N.A.A. BULLETIN

June 1959

In 2 Sections
Section 1

REFLECTIONS ON EDP

FORECASTING TECHNIQUES

COAL MINE ACCOUNTING

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What Accountants Do — Cost Analysis —

Cost Reductions — Vacation Pay

N.A.A. BULLETIN

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This *Bulletin* is published monthly by the National Association of Accountants, 505 Park Ave., New York 22, N. Y. Subscription Price, $10 per year for members only. Second Class postage paid at New York, N. Y.

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Equipment Maintenance Cost Control in Coal Mining

by WAYNE M. WALKER

CONTROL OF THE TOTAL COST of coal production is contingent to a marked degree upon effective control of equipment maintenance. The broad aspects of equipment maintenance encompass not only repairs to equipment during the operating shift but also include:

1. Periodic inspection and preventive maintenance to limit to a practical minimum the losses in production due to equipment failure.
2. A systematic program of providing major equipment components as spares in readiness in the event of breakdowns, thereby reducing potential delays.
3. A definite program of localized engineering research to improve parts which frequently and/or unpredictively fail.
4. A systematic program of major equipment overhauls at predetermined intervals.
5. A sound program of equipment replacement at the optimum time based upon its economical maintenance life.
6. A predetermination of allowed expenditures based on planned production with periodic comparison (at least weekly) with actual expenditures.

This broad program of equipment maintenance necessitates a comprehensive cost control system designed to meet the needs of both maintenance and executive management. Many control systems in effect today are designed primarily for production cost control. The trail has been blazed through time studies, engineering analysis, standard costs, cost analysis, incentive applications, and similar techniques to provide management with the necessary tools for effective control in that area.

A virtually uncharted frontier lies ahead in the establishment of cost control systems for equipment maintenance. The transition from mining by man and

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mule to highly mechanized mining has required less than two decades. Improvement in coal mining equipment continues at an astounding pace. Each year new models differ considerably from counterparts replaced. Although such technological improvements in the long run are beneficial, maintenance control problems are created as a direct result of these improvements. In such highly mechanized operations, maintenance costs, of course, become a significant portion of total mining cost. Substantial monetary savings can be realized from the effort required to establish an effective maintenance cost control system.

This paper presents a case study involving maintenance cost controls for coal mining operations. The subject will be developed in five sections as follows:

1. Background and coal mining equipment maintenance problems.
2. Brief description of the first steps in the major control records.
3. Statement of further objectives of the maintenance cost control system.
4. Recommended specific historical data record system.
5. Benefits realized and expected to be realized from the recommended system.

Coal Mining Equipment Maintenance Problems

The extraction of coal as found in natural formation is widely dispersed over the various active workings of a mine. A typical mining section (specific working area within the mine) involves a producing crew, a direct sectional service crew, and a section foreman as supervisor. In addition, a sectional repairman is assigned to each mining section. His duties are to inspect, lubricate and perform emergency repairs on the mining equipment. The sectional mining equipment includes a mining machine for undercutting the coal, a loading machine, two shuttle cars for transporting the material from the loader to mine cars, a locomotive for hauling the mine cars to the sectional sidetrack and an air compressor and stopers for drilling holes in the roof and installing steel roof bolts.

The over-all height of typical mining equipment for sectional use is only three and one-half feet or less. The width is approximately seven feet, while the length ranges from sixteen feet for an air compressor to thirty-one feet for a mining machine. A typical loading machine is twenty-five feet long, six feet wide, and three and one-half feet high. It has a rated loading capacity of nine tons per minute. This machine has approximately 4,500 parts, of which some 1,500 are different. After eliminating frame and support parts and hardware

items (bolts, oil seals, cap screws, standard fittings, etc.), there remain about 800 different parts which can be considered critical insofar as equipment operation and maintenance are concerned.

There are several inherent physical conditions in mining which impose rigid requirements relative to the design of coal mining equipment. Some of these are low seam height, a large portion of rock partings in the seam proper, steep grades, the presence of water, soft bottom and restricted width of tramways. Further, there is the ever-present possibility of methane gas which necessitates the precaution of enclosing all electrical equipment to prevent an open electrical arc. Such requirements frequently preclude simplicity of design and attendant easy maintenance.

In addition to the aforementioned sectional repairman assigned to each mining section for each operating shift, other mine maintenance personnel consist of an underground roving repair crew, an underground motor pit crew and a surface repair shop crew. Each section of the mine is periodically scheduled to be idle and, during such periods, the roving repair crew makes regularly scheduled trips to it. This crew works on the sectional equipment for two or more consecutive shifts, performing thorough inspection and preventive maintenance functions which would appreciably delay the mining operation if performed during the operating shifts. One function of the motor pit crew is to procure repair parts from the storehouse for emergency repairs which are performed either in the motor pit or in the mining section. The motor pit crew also repairs and/or rebuilds assemblies, inspects and lubricates sectional and main line underground locomotives and general underground equipment. The surface repair shop crew performs regularly scheduled major equipment overhauls requiring shop work and maintains surface facilities.

A mine operating ten sections per shift will have approximately eighty major units of sectional mechanical equipment. This equipment (mining machines, loaders, shuttle cars, air compressors, and sectional locomotives) will be assigned to eleven different mining areas (including one section as spare) and different units of the equipment will constantly be undergoing overhaul. Due to the relatively short life of mining equipment and continuing improvements in design from year to year, the eighty major units of the five basic types of machines may include fifteen different models. This means that, on the average, only five machines are of the same model. After eliminating parts which will interchange between models, there are about 10,000 different parts on sectional mining equipment which are considered critical insofar as equipment operation and maintenance are concerned.

Basic Records and Control Objectives

Maintenance control records are detailed generally to class of equipment, such as mining machines, shuttle cars, air compressors, loaders, etc. These records exhibit budgeted repairs and maintenance cost, actual cost and variance for the month, also for the year-to-date at the end of each quarter. Control data are recorded on visible edge cards which are filed in book units. There is a separate card for each general class of equipment for each mine. Each month the units of production (net tons of coal) handled by the respective classes of equipment are recorded on the visible record card. Maintenance costs are detailed as to labor and material and the budgeted as well as actual cost and variances are shown. A colored signal along the visible edge of each card indicates percentage variance for the year-to-date, favorable or unfavorable. Exhibit 1 is an example of the Repairs and Maintenance Equipment Register.

It may be noted that material usage for mechanical loaders has exceeded the budget for the year-to-date by $8,300 or 29.5 per cent, whereas labor reflects a favorable variance of $291 or 1.1 per cent gain. However, although indicative of over-all trends, these records are inadequate with respect to focusing attention of management on specific contributing causes of excessive maintenance and/or delays.

With technological advances and the many alternatives involved in engineering design and application, virtually any one specific part of the mechanical equipment which is failing repeatedly can be improved by increasing its size, by changing the quality of materials utilized, by metalizing, or it may be eliminated entirely by redesign of certain components of the equipment. This technique

REPAIRS & MAINTENANCE — EQUIPMENT REGISTER — MINE NAME: WOODLAND MINE

DATE	NET Cons.	BUDGET LABOR	BUDGET MATERIAL	BUDGET TOTAL	ACTUAL LABOR	ACTUAL MATERIAL	ACTUAL TOTAL	VARIANCE LABOR	VARIANCE MATERIAL	VARIANCE TOTAL
JAN.	99910	5085	5195	10280	5152	7444	12596	(57)	(2249)	(2316)
FEB.	82665	4216	4289	8505	2889	3709	6598	1327	580	1907
MAR.	94293	4809	4903	9712	4633	6710	11343	(324)	(1807)	(2131)
1st QUART.	276868	13630	14387	28017	12674	17863	30537	946	(3476)	(2530)
APR.	87726	4576	4666	9242	3623	5785	9408	953	(1119)	(166)
MAY	92654	4725	4818	9543	5806	5719	11525	(1081)	(901)	(1982)
JUN.	80530	4110	4190	8300	4637	7004	11641	(527)	(2814)	(3341)
2d QUART.	337828	27031	28071	55102	26740	36371	63111	291	(8300)	(8009)
TO DATE										

Note: Figures are hypothetical. Parentheses denote red figure.

CODE 913 — DESCRIPTION: 14 BU Loader — MACH. NO. 991 — VARIANCE PER CENT. YEAR TO DATE — % LOSS ⟵ 0 ⟶ % GAIN

EXHIBIT 1

is demonstrated frequently in automobiles, household appliances, sporting goods and many other products.

Many of the component parts of mining equipment which have created frequent prolonged delays and/or significant maintenance costs in the past have been previously pin-pointed for study through observation by maintenance supervisors. It was known, however, that many others were not being detected and were consequently being allowed to continue without correction. With the large number of critical parts involved, the dispersion of operations, and the large number of individual repairmen working at widely separated locations, it is virtually impossible to pin-point, through use of memory alone, specific parts which are repetitively failing.

The objective of a maintenance cost control program is primarily to provide adequate detail recording which will permit the pin-pointing of specific parts for study. This program should permit follow-up to determine if remedial action is effective and, in addition, should provide information for determining the comparative merits of equipment from different manufacturers. Further, it should provide adequate information on which to base decisions with respect to retiring equipment nearing the end of its economic maintenance life. A long range objective in this connection, should be a method of determining labor performance on maintenance functions.

Specific Historical Data Record System

Based upon these objectives, a pilot installation of a new system was placed in operation about a year ago for one of several mines and covered all major face production equipment in operation at that mine.

The specific historical data are recorded on visible records on two general types of cards which are filed in visible edge card record cabinets in the office of the superintendent of maintenance. Assemblies Exchanged or Repaired—Loader (Exhibit 2) is an example of the master or accumulator card. The headings on this card vary with the type of equipment involved. Across the top of the card are columnar headings for data and the name of assemblies, or components, classified as to major categories such as electrical, hydraulic, traction, conveyor, spray, etc., as well as equipment delay hours and maintenance man-hours. A separate accumulator card is provided for each major piece of face equipment. Entries to the record show the date and, under the appropriate assembly, also show by symbol whether that assembly was repaired, exchanged, or adjusted and the maintenance man-hours involved. The visible

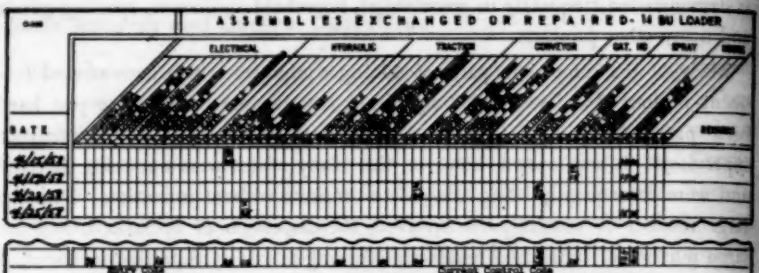

EXHIBIT 2

edge of the card, in addition to equipment description and number, indicates the status as to scheduled overhaul, whether equipment is in active use or is spare, undergoing overhaul, or waiting for parts.

On Exhibit 2 the current control portion of the visible edge of the card denotes that Loader No. 30 is in the shop for overhaul. By scanning the card, it may be noted that frequent failures of the gathering head unit of the loader have occurred. In addition to cost of labor and parts involved in making repairs, delay costs are a significant portion of the total cost of equipment failure. Based on the concept that all mining costs can be absorbed only by sectional face time, the cost of a sectional delay of one hour is approximately $100. Thus, we find for the period shown that total delay time (Column 64) was 33.7 sectional hours evaluated at $3,370. Delay time does not necessarily coincide with total maintenance man-hours. For example, delays on the gathering head unit (in Column 54) totaled 11 hours at a cost of $1,100 but two entries (of 6 and 45 maintenance man hours) did not involve delays.

The other general type card is the detail assembly card entitled Parts Used (Exhibit 3), on which is recorded the date of entry, the equipment classification, the equipment number and, by symbol, whether the work was performed by the sectional repairman, surface shop crew or by the roving repair crew. Parts used are detailed by catalog number and description. Small hardware parts such as bolts, cap screws and lock washers, etc., are not recorded. Equipment delay time and maintenance hours involved are also recorded.

Entries to these two visible record cards are based on reports prepared by the sectional repairman, the motor pit crew, the roving repair crew and the surface shop crew. Posting to the visible record card is performed by an ac-

counting employee who reviews and analyzes the accumulated data and reports the results of such analysis to the superintendent for corrective action, on an exception basis.

Based upon experience in this pilot installation, the benefits from such a record system, though intangible, have a substantial potential. During the period the system has been in effect, numerous changes in design have been made and incorporated in new equipment and manufacturers have furnished modification kits, of which some were at no charge, for use in altering present equipment. Experience has been that, when specific instances of failure can be cited to the manufacturer, more attention is given to correcting the defects or improving the parts involved.

The superintendent of maintenance reviews for indicated trends data furnished him from the visible record. He assigns engineering personnel to make a preliminary investigation of parts which the trends indicate warrant specific study. After adequate information has been developed by engineering personnel with respect to physical and metallurgical characteristics of the parts involved, and other pertinent data, a "brain storming" session is held, usually at the monthly maintenance meetings, to determine appropriate remedial action.

The past year's experience indicates that the pilot system is the beginning of a very effective control of coal mining maintenance costs. It is realized, however, that it is only a beginning, with much more to be desired. Plans to achieve full coverage are under way. It is recognized that this system comprehends recording and selecting for reporting on an exception basis such a mass of data as to preclude its timely availability for use if handled manually. The most efficient administration of such a system necessitates use of punched card equipment or use of electronic computers, which is a part of future plans.

DATE	EQUIP.	YD NO.	S/A	O/H	SCR. REP.	PARTS USED		EQUIP DELAY	MAN HOURS
						CATALOG NO.	DESCRIPTION		
5/26/59	14BU	20	R			2-M 6/8 Type Bearings 2-M 7906 Dust Rings	REPAIRED SWING ARM	6.0	6.0
5/26/59		28	R			1-M 7906-RB	REPAIRED DRIVE CHAIN	.8	.8
5/26/59		38	R			2-M 6/8 Type Bearings 2-M 7906 Dust Rings 1-M 14BU Swing Arm	X OUT SWING ARM & BEARINGS	40	40
6/6/59		30	R			1-M 14BU Sprocket	X OUT DRIVE CHAIN SPROCKET	3.0	3.0
6/6/59		38			R		REBUILD AND INSTALL CATALOG NO. 6 AND 7906 RINGS		6.0
							Note: Figures are hypothetical.		
						*Work performed by Sectional Repairman. **Work performed by Surface Repair Shop Crew. ***Work performed by Roving Repair Crew.			
CAT. NO.	ASSEMBLY DESCRIPTION					MODEL	DRAWING NO.	REF. NO.	
U-106-28A	GATHERING HEAD UNIT					14BU-7RBE	U-106-28A	57	

EXHIBIT 3

A Report Designed to Probe Parts Failures

Another planned feature is a report which, on an exception basis, will pinpoint areas (assemblies and specific parts involved) of repetitive equipment failure. A Report of Selected Repetitive Maintenance Costs by Equipment Assembly and Part Number (Exhibit 4) has already been designed to meet this need. This report, which will be prepared monthly, is divided into two sections. One section summarizes by assembly the cost per 100 equipment operating hours of the regular maintenance (detailed by labor, critical parts used, and delay costs) and cost of equipment overhaul (detailed by labor and critical parts used). This information is shown for month and year-to-date. When the cost per 100 equipment operating hours for an equipment class exceeds a predetermined cost set by engineering and historical studies (which can be revised by changing the listing determinant amount), the detail by individual equipment number will be printed out on the report.

The other section of the report involves specific parts used. The initial detail for this section of the report will be on a selective basis when the cost per 100 equipment operating hours for an individual piece of equipment exceeds a predetermined amount set by engineering studies. This listing will be based on a request from the superintendent of maintenance for the entire record on usage of parts specified in his request. Generally, the list will be based on information shown on prior reports which indicated the need for special engineering study.

For example, on Exhibit 4, the selected listing determinant for summary

REPORT OF SELECTED REPETITIVE MAINTENANCE COSTS BY EQUIPMENT ASSEMBLY AND PART NUMBER

COST PER 100 MACHINE OPERATING HOURS

ASSEMBLY NO.	ASSEMBLY DESCRIPTION	EQUIP. CLASS	EQUIP. NO.	LISTING DETERMINATE AMOUNT MACH.	LISTING DETERMINATE AMOUNT PART	OPERATING MAINTENANCE THIS MONTH: LUBE INSP. & ADJ.	LABOR: EXCH. ASSEM.	REPAIR	CRITICAL PARTS	DELAY COSTS	TOTAL	YEAR-TO-DATE: OPERATING MAINTENANCE: LUBE INSP. & ADJ.	LABOR: EXCH. ASSEM.	REPAIR	CRITICAL PARTS	DELAY COSTS	TOTAL	OVERHAUL: LABOR	CRITICAL PARTS	TOTAL
704	GATHERING	140V	29	25.00	15.00			5.00	14.00	-	19.00		1.50	2.90	8.90	25.50	38.78	-	-	-
"	HEAD UNIT	"	20	"	"			10.90	20.15	49.50	80.15		-	9.20	26.45	37.80	73.45	11.15	16.27	27.42

MONTH OF JUNE, 1950

CRITICAL PARTS (LISTED ON EXCEPTION BASIS)

PART NO.	PART DESCRIPTION	QUANTITY THIS MONTH: REGULAR MAINT.	OVER-HAUL	QUANTITY YEAR-TO-DATE: REGULAR MAINT.	OVER-HAUL	TOTAL	QUANTITY PER 1000 EQUIPMENT OPERATING HOURS: THIS MONTH	YR.TO DATE	COST PER 1000 EQUIPMENT OPERATING HOURS: THIS MONTH	YR.TO DATE
14041	SPROCKET	1	-	1	-	1	3.33	.98	112.07	32.31
4343-1	DRIVE CHAIN LINK	1		4		4	3.33	3.33	2.57	2.57
4343-42	DRIVE CHAIN	1		1		1	3.33	.98	80.84	25.02
0-134420	BEARING		4	3	4	7	13.33	5.83	182.55	78.84
7088	DUST RING		4	3	4	7	13.33	5.83	4.67	2.06
14380	SWIVEL ARM		1	2	1	3	3.33	2.50	342.08	298.62

EXHIBIT 4

information on the loader is $25 or more per 100 machine operating hours. The total cost of Loader 29 exceeded this amount. Therefore, it was listed. Since the critical parts costs, however, did not amount to as much as $15 per 100 machine operating hours (the listing determinant amounts for critical parts), the parts detail was not shown. The cost of Loader 30 exceeded the total of $25 and of $15 for parts. Therefore, the complete detail was printed out for this equipment. A study of the critical parts used on Loader 30 focuses attention on several specific items.

Bearings and dust rings used in the gathering head unit are obviously costly maintenance items. Contamination due to coal dust and water reaching the bearing is the problem. The solution may well lie in a better, more abrasive resisting dust seal, a better water resistant lubricant, a sealed bearing, redesign of the bearing housing or a combination of changes. The problem has been pin-pointed and is currently being given thorough study. Failure of swivel arms is another costly maintenance problem. Although the drive unit is equipped with a friction clutch which is designed to slip under abnormal pressure, swivel arms are, nevertheless, broken because of the speed of travel and impact effect when a large rock is encountered. The swivel arm usually breaks before the shock of the impact can be mechanically transmitted to the friction clutch. This problem is also under engineering study.

Comparing Equipment

For use in evaluating the comparative merits of equipment from different manufacturers and to provide basic information for use in determining the optimum time to replace the equipment based on its economic maintenance life, an annual report is prepared on total maintenance experience for each piece of equipment. A similar report may be prepared at any time, as required, for each class of equipment for investment appropriation considerations.

A Good Beginning

While much progress has been made in maintenance controls, it is realized that the real job has just begun. To date, maintenance cost has been reduced approximately seven per cent. Although this has been a case study in the coal mining field, the principles and concepts involved in establishing maintenance controls apply to many other areas in which maintenance costs are significant and operating units to be maintained are numerous.

Cycle Payment of Vendor Invoices

by R. E. BEERMAN*

WE RECENTLY CHANGED to the cycle system for paying vendors' invoices. Our suppliers number in excess of 16,000, of which about half are considered active. Over the past few years, a definite trend in their preference as to payment dates has been noted. This trend is for payment twice a month—on the 10th and the 25th. In our attempts to meet this trend, we found we were encountering tremendous work peaks. Another problem was that of discount terms. Many suppliers imposed terms of "net cash" or "one per cent ten days" Because of our wide spread facilities, we were receiving invoices from many of these suppliers daily. Consequently, in compliance with the terms of their invoices, we were mailing them checks daily.

The cycle payment plan was recommended to our methods and procedures department as one way of meeting the need for a more constant and a reduced peak work load. The department was asked to make a study and recommend a course of action. An analysis was made of the suppliers in each division of the company to determine which paying dates would comply with the wishes of the majority of the suppliers in the division. Dates were then established to enable us to issue an equal number of checks each working day of the month. We found we could pay invoices for two of the smaller divisions in one day and that, in the larger divisions, payments could be spread over five days within a 2 week period. The analysis also revealed that, under this system, some invoices would be paid before and some slightly beyond the date specified in the suppliers' terms.

Next, letters were mailed to all our suppliers informing them of our proposed system of payments, namely, that we would make two payments each month on specified dates, regardless of the terms on the invoice. We would *always* pay on those days. Naturally, we expected some negative reaction. However, we were agreeably surprised by the response. Very few vendors raised objections. There were some exceptions, particularly the public utility companies. We designed the system to provide for these special exceptions. Also, we required that invoices be processed promptly and new vendors informed of our system for paying invoices, upon their first contact with our purchasing people.

The objectives of reducing and leveling our work load have been met, even though the over-all work load has increased steadily, due to the expansion of our business. There has been a ten per cent reduction in the number of checks issued.

* Supervisor of Accounts Payable, Owens-Illinois Glass Company, Toledo, Ohio.

The Operations Research Approach to the Budget Forecast — A Case Study

by ADOLPH F. MORAVEC

WE HAVE RECENTLY COMPLETED a study in which operations research techniques, budgetary skills, and computer capabilities were successfully teamed together to provide management with the information that it required. The area of application was that of forecasting budgetary needs. This forecasting application had a pay-off despite the fact that it was only a small part of a total data processing job. Also it should be understood that this application does not represent a "Cloud 9" approach to a special problem situation. Rather, the principles can be used by businesses, large or small, as a realistic and practical tool.

Why Forecast — and When and What?

The study of forecasting at Ramo-Wooldridge began with the examination of the question, "Why is it necessary to forecast? What is a forecast?" We answered these questions in terms of the functions of forecasting. (Exhibit 1) A basic function is to project sales and expenses so that the flow of funds and financial requirements of the corporation can be anticipated. Equally important, the projection of sales and expenses previews the expected profit. Contract administration requires forecast information to prepare proposals and bids. Budgeting and future planning are made simpler and more effective if management is working from adequate information. Facilities and equipment planning will be enhanced if forecasting procedures provide reliable information when it is needed. From all this we can safely give a working definition of forecasting. It is the basis for all future activities.

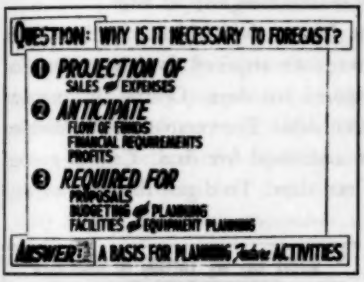

EXHIBIT 1

ADOLPH F. MORAVEC is a member of the Technical Staff for the Ramo-Wooldridge Division at the Thompson Ramo Wooldridge Corporation, Los Angeles, California. He is a specialist in the fields of management analysis, industrial economics and computer applications for business operations.

As a result of investigating these basic questions about the need for forecasting, we learned the symptoms of an inadequate system. Prominent among these symptoms was the length of time it took to produce a complete forecast. It was obvious that the rapid growth of our company had made the production of forecast information more difficult and time-consuming. This problem in its most acute stage was typified by recent forecasts which were invalid by the time they were completed because personnel mix and sales requirements had changed markedly while the forecasting computations were in process. A second symptom of inadequacy was that the week-to-week changes in sales requirements could not be incorporated in the forecasts without indefinitely delaying their completion. It was, therefore, necessary to take the position that the present system was incapable of producing current, valid information.

A number of other symptoms concerned the current method of producing the forecast information. First among these was that the controller's staff found it increasingly difficult to keep up with its total work-load due to the large volume of man days consumed in forecasting under a completely manual system which required large volumes of simple arithmetic computations. An enormous variety of forms and source documents—nearly 100—were required to produce the forecast. The necessity of maintaining a high level of accuracy dictated an excessive amount of double-checking, verifying, recapping and rearranging. Exhibit 2 depicts what the current system necessitated, step by step.

The time required to make a complete forecast was laid out in these seven steps. Department head count and direct costs required five days. Division wage dollars and overhead expenses required ten days. Central or corporate allocated overhead expenses required fifteen days. The computation of division cost of sales and overhead rates took an additional five days. Central general and administrative expenses required fifteen days. To digest this load of data

TIME REQUIRED TO MAKE A FORECAST

	STEPS IN FORECASTING	NUMBER OF DAYS
1	DEPARTMENT HEADCOUNT AND DIRECT COSTS	5
2	DIVISION WAGE DOLLARS AND OVERHEAD EXPENSES	10
3	CORPORATE ALLOCATED OVERHEAD EXPENSES	15
4	DIVISION COST OF SALES AND OVERHEAD RATES	5
5	CORPORATE GENERAL AND ADMINISTRATIVE EXPENSES	15
6	DIVISION SALES AND PROFITS	5
7	CORPORATE FORECAST	5
	TOTAL DAYS	60
	TOTAL WEEKS	12

EXHIBIT 2

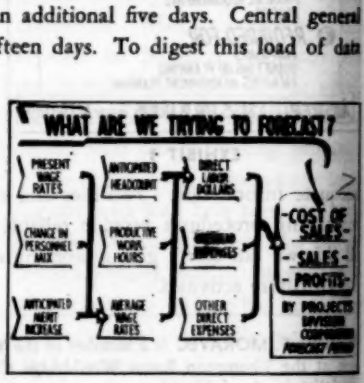

EXHIBIT 3

and obtain division sales and profits took five days. To produce the final document, the division forecast, required an additional five days. It, therefore, appeared that forecasts could not be produced in less than sixty elapsed days, or twelve weeks. We definitely needed a simple, more rapid way of doing this job!

This first look at the current forecasting procedures was aimed at identifying the problem area. To do this, we began a step-by-step process of assembling the information that would describe the present system. If we had correctly assessed the symptoms, it was time to explore the causes and get to the root of the problem. We asked, "What is it we are trying to forecast?" It is clear from Exhibit 3 that we were trying to build a divisional forecast from the most elemental data. We were attempting to describe how many personnel were required for each project that was either in work or anticipated, so we could allocate a specific personnel mix to each forecasting period in the future. In addition to predicting the head count, the present system was allocating divisional overhead and corporate overhead to each forecasting period, so the overhead rates could be used to determine cost of sales, sales and profits.

How We Formerly Forecast Wage and Overhead Rates

If there was any single factor that made the forecasting problem difficult, it was the problem of how to obtain the proper average wage rate by job classification for each project in each forecasting period. These figures were critical in the forecasting procedure because they were used later in the computation of direct and indirect wage dollars. Exhibit 4 indicates in a very simple way the old complex method of computing average wage rates.

It is immediately clear that there were four factors that effected each and every project for which manpower was to be allocated and, at this time there

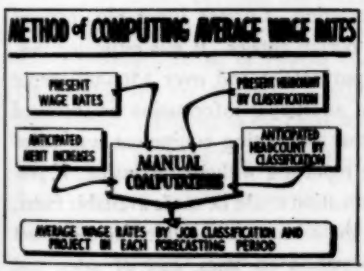
METHOD of COMPUTING AVERAGE WAGE RATES
PRESENT WAGE RATES
PRESENT HEADCOUNT BY CLASSIFICATION
ANTICIPATED MERIT INCREASES
MANUAL COMPUTATIONS
ANTICIPATED HEADCOUNT BY CLASSIFICATION
AVERAGE WAGE RATES BY JOB CLASSIFICATION AND PROJECT IN EACH FORECASTING PERIOD

EXHIBIT 4

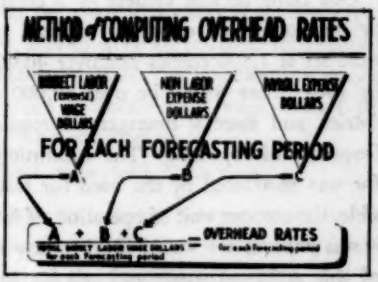

EXHIBIT 5

were over 40 projects. Present wage rates had to be modified by anticipated merit increases. Present head count by job classification had to be amended by the anticipated head count in each job classification. When all of this data was accumulated, it was possible to assess for each project in each forecasting period the average wage rates by job classification. Note, however, that each project required a wealth of data and each project had to be added into the total picture, a piece at a time — on a completely manual basis. It was no wonder that it required three months to complete a forecast and that errors occasionally crept into the maze of arithmetic calculations!

But now we can proceed to Exhibit 5. Given the average wage rates, how was the overhead rate computed? You will remember that, to make a forecast, we allocate exepenses to each project in each forecasting period. This means that the various overhead items such as indirect labor, non-labor expense and payroll expenses must also be accumulated in a similar fashion. In fact, this was being done on the same laborious manual basis we observed earlier. The controller's staff allocated dollars to each project in each forecasting period to spread properly the overhead costs that were anticipated in the future forecasting periods. However, before overhead rates could be obtained, the average wage rates had to be multiplied by the anticipated direct head count, and hours, project by project. This produced the total direct labor wages dollars for each project in each forecasting period.

With all the pertinent overhead costs assembled for each forecast period, the final computation was to divide these by the total direct labor wage dollars for the identical periods. The resulting overhead rates were now ready for use in allocating overhead dollars for each project in each forecasting period, with the intent of determining the cost of sales and potential profit. Even this is not the sum total of the system. There were other inputs, such as productive work hours, which required extensive computation.

One thing became evident — a computer application was certainly indicated by the volume of data that required processing. Current input requirements were set at 7,500 entries and over 40,000 output entries. It was estimated that, by 1961, there would be over 30,000 input entries and over 150,000 output entries, and more if management required additional information or increased frequency of reporting. The conclusion that computing equipment was called for was reinforced by the need for faster reporting without increasing, if possible, the cost per unit of operation. If information could be made available faster, it was obvious we would obtain many of the advantages outlined at the outset of this article—current and reliable information on sales, cost of sales, and profits to guide management in its decision making.

Re-Forming Wage Forecasting Methods

In making a computer application, we had several alternatives. The first of these was to make a one-for-one changeover and go through each of the processing steps as they were originally done, but do them faster. This did not seem practical in the present case. We felt that a more efficient and a simpler system could be developed whether we used or did not use a computer. A detailed examination of the data was begun and soon it appeared that there was a novel approach to the problem of simplifying the computational tasks. After careful analysis we decided that the statistical technique of regression analysis could be applied successfully to this problem, with improved results. The technique of regression analysis revealed the relationship that is illustrated by the regression line on Exhibit 6. In effect this line indicates that, as head-count increases, there is a straight-line relationship with total wage dollars per hour. The points plotted represent the relationship between head count and total wage dollars per hour in different months. (All numberical values represented in this paper are fictional and are used for explanatory purpose only.

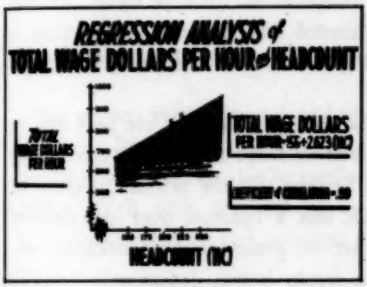

EXHIBIT 6

COMPARISON of FORECAST & ACTUAL

1	2	3	4	5	6
PERIODS TESTED	HEADCOUNT (ACTUAL)	TOTAL WAGE DOLLARS PER HOUR (ACTUAL)	TOTAL WAGE DOLLARS PER HOUR (FORECAST)	WAGE DIFFERENCE OF FORECAST FROM ACTUAL	PER CENT DIFFERENCE
JAN	160	644.68	649.97	5.29	+.8
FEB	170	667.85	678.17	10.32	+1.5
MARCH	180	763.33	758.73	5.40	+.8
APRIL	197	847.88	819.45	28.43	-3.5
MAY	205	867.80	858.31	8.49	-1.0
JUNE	220	965.25	982.49	17.24	+1.6

EXHIBIT 7

The line drawn between the points on the chart in Exhibit 6 is represented by an equation. The advantage of being able to write an equation representing this regression line is, of course, convenience. With the equation, a person can quickly do the arithmetic computations to obtain total wage dollars per hour without referring to the chart at all. This equation is:

$$\$55 + \$2.623 \text{ (HC)} = \text{Total wage dollars per hour}$$

It appeared to satisfy the system requirements. It was now necessary to test this equation to determine its reliability. One of the tests of reliability is the statistical technique known as the coefficient of correlation. In effect, this coefficient would measure the closeness of fit between the points on the chart and

the line which goes between them. When the coefficient of correlation was calculated for these six periods, it was found to be .99. For the record, 1.00 would be perfect correlation!

As shown on Exhibit 7, we tested six monthly periods. For each of these periods we moved from the head count listed in Column 2 to the total wage dollars which we would have forecast by our regression line (Column 4). In Column 3 appear the actual dollars as they resulted from the personnel mix of that month. Column 5 shows the difference in the forecast and actual dollars and Column 6 the per cent deviation. This deviation was found to be well within the requirements of the system for accuracy.

Looking back we can ask the question, "Exactly what advantage did the regression analysis technique give the proposed forecasting system?" It was clear that the regression technique simplified the computation of total wage dollars per hour. What formerly had to be computed by lengthy, tedious, manual means requiring many inputs, was now producible with only two inputs. The elimination of a cumbersome technique had, in addition, created a new system that could operate more economically. The other essential improvement was the increased speed with which computations could be made. To this point in the new system, it has been estimated that the reduction in time is about 70 per cent! What the computer might add in terms of additional speed remained to be seen.

Once the total wage dollars per hour had been determined, the next step in determining average wage rates was to distribute these dollars over the various job classifications. From Exhibit 8 it can be seen that the percentage share of payroll dollars for each job classification was a constant over six months. After analyzing the data, it was found that the professional classification was 48.1 per cent of the total payroll. As a result, it was determined that this classification and all other classifications would fluctuate to such a small extent

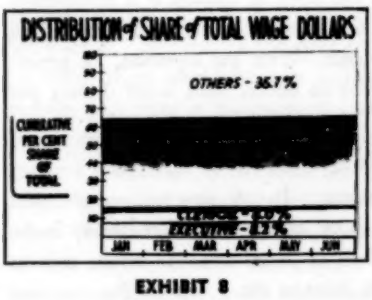

EXHIBIT 8

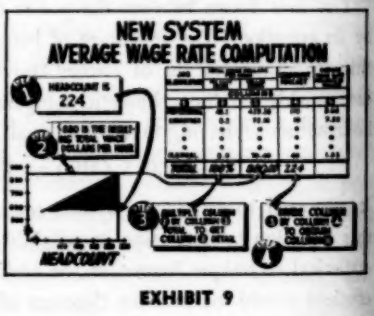

EXHIBIT 9

that, in effect, they could be looked upon as constants. With these constants to work with, the next step of distributing total wage dollars per hour to each job classification was a simple matter.

We can now move through the process of obtaining average wage rates for each job classification (Exhibit 9). We start with the familiar regression chart. For example, if the division forecast a total of 224 employees, it is a simple matter to use our formula to find total wage dollars per hour. In this case, it happens to be $880, indicated in step two. Now, looking at the table on the right side of the chart, we find our job classifications in Column 1. Column 2 indicates the per cent distribution that we discussed previously. We can see in Step 3 that, by multiplying Column 2 by the total of Column 3, we obtain the distributed dollar share of the total wage dollars per hour to each individual job classification. Then, as indicated in Step 4, by simply dividing Column 3 by Column 4, which is the forecast headcount for each job classification, the average wage rates per hour are obtained in Column 5. This method of computing wage rates per hour proved to be faster than the original system by a factor of ten!

Application of Method to Non-Labor Expense

The general method just described is the basis of the new forecasting system applied at Ramo-Wooldridge. The method illustrated for the computation of average wage rates can also be applied to the computation of non-labor expenses dollars. Both were obtained by using regression analysis which eliminated the manual operations and increased the speed of availability of the information.

The System as a Whole

You have read the important details of the new forecasting system. Now we can look at the overall system and see how it functioned in a more simplified manner than the old one. You will observe (Exhibit 10) that we now need only two basic inputs—headcount and productive work hours. In the old system, we needed not only these two inputs but also a considerable number of other basic inputs. From only headcount and productive work hours, we are now able to arrive quickly at direct and indirect wage dollars and all the overhead expense dollars. Once this information has been obtained for each project in each forecasting period, it is a simple matter to compute future overhead rates, cost of sales, total cost of sales and sales dollars.

To determine the reliability of the system's design, the new system was operated manually. In this way, each step of the data processing was checked to be certain of its position in the preparation of the forecast. The final phase of the study was divided into four activities. The first activity was the writing of a program for the computer. The second activity was concerned with the design of new input documents and output reports, to accommodate a more simplified presentation of forecasting results. The third activity embraced the preparation of written procedures to describe adequately all phases of the new forecasting procedure. The fourth activity centered about the development of computer routines for controlling and checking the equations used in the regression technique. In addition, we undertook the development of routines so that the computer would develop the regression formulas without human intervention.

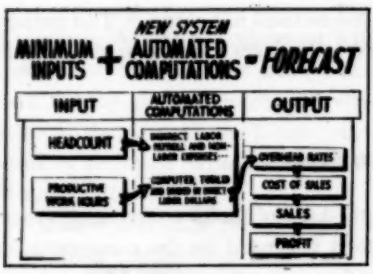

EXHIBIT 10

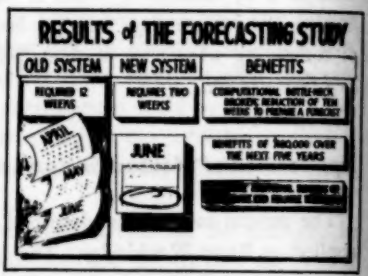

EXHIBIT 11

Now we can look at what might be called the over-all results (Exhibit 11). We were approached at the beginning with a general problem. The statement of the problem was "to reduce the preparation time required to prepare a forecast." As a result of our study and putting the forecast on the computer, preparation time was reduced from thirteen weeks to two weeks. In effect, the computational bottleneck had been broken and the goal of the study had been reached. However, there were some additional benefits obtained as a result of undertaking this project which can be classed as unanticipated by-products! A saving of $180,000 was estimated over the next five year period. Reliable, accurate and current information is now available. The new system is flexible to expand and contract with changing business needs and conditions. Additional data can be obtained at a very small marginal expense. We have a simple and quick method of obtaining revised forecasts. Finally, customer proposals can now be prepared on a more competitive basis.

It is in the manner illustrated in this article that the principles of operations research can be applied. While it is difficult to specifically define the term, the important point to remember is that operations research is the name applied to the scientific study and analysis of management problems aimed at maximizing or optimizing the effectiveness of a company's over-all operation. As for its place among the other management services, operations research serves as an adjunct to, not a substitute for, services such as research, market research, statistics, accounting, production control, inventory control, and others. Operations research draws upon information from all of these fields to enhance the sum-total objective of the company. Perhaps the best method of explaining the role of operations research is by way of discussing an actual problem and the manner in which it was solved. Hence, this article!

A Challenging Problem of Paint Application Standards

by D. H. COLBY*

FOR THE BENEFIT of others who may be faced with a similar situation, I should like to describe briefly a problem we had in the determination of material cost standards and the steps we took for its solution. Our particular challenge was the determination of accurate and usable material cost standards for a high speed, semi-automated, spray painting operation.

Parts to be painted are hung on an overhead "monorail" and thus transported through the system. As they pass through the paint booths, the spray guns are manually activated. The gun nozzles are set at a fixed opening and paint is fed under pressure from a central tank. The parts to be coated vary in the extremes from items similar to a flat piece of 1/32 inch stock 16 inches square to an item 4 feet long by 1½ feet wide resembling the checkered appearance of an automobile radiator grille. In the first case, the nature of the spray equipment caused considerable amounts of paint to be lost by being sprayed past the part around the edges and, in the second

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case, a considerable amount of material was used which never actually remained on the part but was sprayed through the many holes and absorbed into the water-fall type waste system.

The type of manufacturing operation prohibits long runs of the same item and, in one day, many different parts of various sizes, shapes, and configuration are processed. We needed a method by which to determine the gross amount of paint sprayed at each different piece in order to set cost standards by type and we needed a method that was usable in quickly estimating costs of proposed parts. The history was that plant engineering personnel had worked on the problem for several years and had been unable to arrive at an accurate or usable method of determining standards. Several bases had been tried in an attempt to arrive at a solution: displacement, weight, effective areas, and others, all of which proved to be extremely inaccurate and/or inconsistent.

Our approach was to take a positive and a negative attitude simultaneously. We knew that the paint spray guns had a standard opening and that the amount of paint used was a direct function of gun-open time. We arbitrarily picked a figure at random as the amount of paint flowing from an open gun. In this case we used 11.2 gallons per hour. We knew that this was not correct, but, as you will see, it was the determinant in arriving at a correct figure. With the cooperation of time study engineers, we determined the gun-open time, that is, the number of seconds that each spray gun was pointed at a part, with paint flowing from it (the guns being manually operated). This time was determined for each currently active part passing through the line over a three-month period. Test cost standards were set by multiplying gun-open time by 11.2 gallons per hour. Weekly, all production was costed and compared to the actual quantities of paint used, and, over a period of three months, a consistent ratio evolved. We could see that this ratio of actual to standard was 75 per cent. This proved that our rate of flow was actually an average of 8.4 gallons per hour, rather than 11.2 which we had previously assumed. From here on, the rest was extremely simple. Determination of a standard or a figure for estimating was arrived at by an accurate time study or a reasonably accurate estimate from the scale drawing to which was applied our now-known rate of flow and this in turn converted to dollars.

It seems appropriate to point out that imagination and some out-of-the-ballpark thinking brought about the solution of a serious problem. This type of situation continually emphasizes the importance of imagination, open mindedness and the application of common sense as necessary and required tools of our profession.

Management's Right-Hand Robots

by ROBERT J. FITZPATRICK

FROM THE HANGING GARDENS one could see the dusty market place of Babylon. There under the shade of a tattered burlap sat Allit, Son of Sinam, the well-known public scribe. Standing before him were two traders and on his lap was a board supporting a clay tablet. Squinting from the brightness of the noonday sun, Allit pushed a stylus deftly into the moist clay and wrote:

> "Forty tetradrachma owed. Larassib, Son of Bel-akhe-irib, will pay into the hands of Zir-Idin, Son of Hablai, in the month of Iyar, 40 tetradrachma, in the Temple of the Sun, in Babylon."

Having recorded the transaction, Allit placed the tablet in the sun to dry.

Walking toward the office in the early morning, Mildred Davis can see the huge towers of the Commonwealth Edison building framed against the gray sky. At eight thirty, she seats herself at the console of an electronic data processor. An air conditioner protects her and the machine from heat and dust. At eight thirty-five, she pushes the proper buttons and the machine will begin to prepare bills for 1,800,000 customers to be paid at the office of the company or some authorized agency.

The data processor works with the speed of ten thousand Babylonian scribes. Drop a pencil from waist height to the floor, and about one-half second will elapse. During this particle of time the computer can do seven hundred multiplications of two five-digit figures, or, say, 52, 892 $\times$ 69, 767, seven hundred times. If the best-seller of the late thirties, *Gone with the Wind*, were translated into symbols understandable by the machine, an electronic data processor would "read" the book in four minutes. What changes does equipment such as this portend for modern business?

Two Kinds of Computers

Since the turn of the century, the number of clerical workers in business has grown four times as fast as the number of direct workers. The correspond-

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ROBERT J. FITZPATRICK, Louisville Chapter, 1953, a Certified Public Accountant, was formerly associated with Lybrand, Ross Bros. & Montgomery and with the Brown & Williamson Tobacco Corporation. He has been Chairman of the Accounting Department of Bellarmine College, Louisville, since 1953.

ing increase in the cost of handling paper and other clerical duties has put pressure on management to reduce those costs, and scientific research has come up with an answer—the electronic computer. The mathematical or analog computer designed mainly for scientific applications was the first development. This type of computer can aim an intercontinental missile, plot trajectory, make corrections while the missile is in flight and guide it to the target. However, it talks in the language of logarithms and higher mathematics and is designed to solve a few complicated mathematical problems in a split second. Its use in solving business problems, therefore, is limited.

Business problems are concerned with the handling of many small items and require, usually, only simple mathematics. Scientists, therefore, realizing the need to modify the computer to handle business data efficiently, came up with the digital computer. It is not to be confused with the older type of equipment which, although electronic, uses punched cards for handling most data. The true high-speed electronic data processing equipment (E.D.P. for short) uses magnetic or paper tape for transmitting data and is a device capable of performing mathematical and logical operations entirely within itself. The machine must have received proper instructions or programming, as it is called, but, once having been told what to do, will follow all the steps automatically.

There are two classes of such computers, general purpose and special purpose. The former, as their name implies, are electronic machines which do all types of arithmetical computations—add, subtract, multiply, divide, and extract square root. In addition, general-purpose computers are capable of performing a large number of other operations. They can store data, compare items, prepare reports, and so on. As a result, they are very versatile. For example, they can do the payroll, handle accounts receivable and billings, do cost accounting, production scheduling, and budgeting. Special-purpose electronic computers are limited either as to the type of computations they can make or as to the functions they can perform. In contrast to the general-purpose computer, the special-purpose computer is designed for separate aspects of data handling.

Of principal concern to management, however, are the questions:

1. What practical use has already been made of electronic data processors?
2. What is the outlook for newer uses in the future?

Applications of electronic data processing already well established include processing of payrolls, inventory control, airlines reservations, and production control. Still in the exploratory stage and among the possible future uses are:

general and cost accounting systems, sales and financial forecasting simulation and risk studies, and coordination of E. D. P. with assembly lines. We will have a brief look at each one of these present and possible future applications.

Current Applications in High-Volume Areas

Payroll applications, although prosaic, have often provided the pay-off for the initial installation of electronic equipment. This has been the case at General Electric, U. S. Steel, and Ford. Some of the reasons for this are that payroll operations are largely routine, the volume of work is tremendous, and a large number of clerks is generally needed in a manual or even a punched-card system. Where the payroll is large enough, from the point of view of the number of employees, the introduction of electronic equipment may promise an immediate savings over a period of only a few years. Any other work which may be handled by the equipment is often of the nature of a "bonus".

Although payroll procedures are relatively simple from an accounting point of view, the problem of programming a payroll system on such equipment can be rather troublesome. General Electric's large Appliance Division in Louisville, for example, began actual programming on its new system in the fall of 1953 and expect to finish the job by May 1954. Due to unexpected difficulties, however, the first payroll was not run off until the fall of 1954.

Inventory Control serves as another example. John Plain, in the wholesale mail-order business, carries about 8,000 items in inventory and ships to thousands of customers. Daily orders may vary from 2,000 to 15,000, with an average of ten items per order. Keeping track of inventories and seeing that they are well balanced can be a headache for this type of firm. It was a headache, in fact, even with a small army of sixty clerks to keep tabs of the stock on hand. Even with this help it was possible to give only weekly reports to the buyers.

Plain presented its problem to Remington Rand, who came up with a specialized type of data-processing equipment called the "speed tally". (Plain calls it the distribution.) This new equipment calls for only seven operators who require a minimum of training. The speed tally will produce the balance of any inventory item at any time and thus permits the operators to answer immediately telephone requests by buyers for information on specific items. The total for all items on hand may be printed out at the rate of 75 a minute in any desired order.

A good production control system makes the most efficient use of productive plant capacity. In a manual system of scheduling and production control, a

tremendous amount of clerical work is needed with resulting high costs and relatively slow delivery of data. Complications arise especially when there are changes in the production plans resulting from variations in sales or in manufacturing methods.

The University of California made a study of electronics as applied to a large job shop employing about 1,000 persons. The shop had been using a manual system of production control based on the use of control boards. The main problem faced by the firm was to estimate the workload on each machine tool section. The problem was complicated by the fact that the shop produced various products and that there was no standard flow of materials from one machining section to another. In other words, if production was not properly planned, bottlenecks could develop at points where materials piled up for processing at certain machining sections. In the past, since adequate advance planning was impossible, these emergencies had to be handled by frequent "expediting."

The electronic system, which replaced the manual system, however, was able not only to locate every job in process but could immediately spot the jobs which fell too far behind a given rate of progress. In addition, the new equipment kept tabs on parts inventories and gave the signal to re-order before shortages developed. A special purpose computer was set up to handle the problem of scheduling. The shop orders were "fed in" and the computer automatically projected the routing of each order through the various machinery centers. When a machine tool was shown to be idle, the computer reviewed the pending shop orders scheduled to go through this particular machining center and picked the order with the highest priority. The order could then be moved up to fill the temporary idle gap. As computer operating time was only fifteen minutes for each forty hours of plant operations, it is evident that a few minutes spent in working out a production problem on a computer could avoid a considerable amount of wasted time and money in actual production.

Lockheed Aircraft offers another case in production control by electronic equipment. The company expanded rapidly from World War II to 1950 and, instead of reducing costs as production increased, found that its costs per unit increased. The reason, in part, was difficulty in production scheduling. The company then began processing its production orders on an I. B. M. 701 computer. With this system, it has planned schedules in a few hours which previously took more than a week to prepare. As a result, production planning at Lockheed has been more efficient and has resulted in lower costs. Looking to the future, Lockheed management plans to develop "factors" for use in future programming and scheduling, using material costs, costs of labor required,

availability of storage space and other factors. These factors can be used to estimate costs and production time on pending orders. They may also provide a "standard" or measuring rod to compare with actual costs and other real elements of production as manufacture of actual orders progresses.

On the general picture of electronics and production, since so much information originates in the factory and since electronics is of major importance in factory automation, the crystal gazers say that it will not be long before computers will receive information from the factory and then make automatic decisions which will vary and control production procedures by issuing instructions directly to the production machines on the assembly lines.

Billing procedures for public utilities and insurance companies have been readily adaptable to highspeed electronic equipment. Here a large volume of relatively small items makes the installation of the equipment economical. A somewhat similar application is the Bank of America's electronic system for handling checks and checking accounts. As these applications are more specialized and are not particularly suitable at present to industrial use, they are mentioned only as a matter of interest and to illustrate the wide range of applicability of electronic equipment.

What of the Future?

So far, then, electronic data processing has been adopted mainly for one or a few applications where immediate advantages or savings may be realized. The field of electronic data processing has grown so rapidly, however, that many management people find they are unfamiliar with it and have not been able to take full advantage of its opportunities. Let us look at the possibilities for the development and use of electronic applications in the future.

A complete accounting system is exceedingly complex and, although not impossible, it would be a monumental task to program an entire system on electronic equipment. Programming General Electric Company's payroll alone, for example, took one full year. Cost accounting, likewise only a part of the entire system of reporting, is similarly highly complicated in many cases. Therefore, general and cost accounting applications have not been encouraged as one of the first for electronic computers. Full development along these lines has had to wait for more general purpose equipment.

However, cost systems are more readily adaptable to treatment than general accounting systems. It is easy to visualize the possibility of first feeding standard costs into the memory unit of the computer prior to the end of each financial

period and then developing actual costs, instructing the computer to provide automatic comparison of standard with actual costs, and reporting unusual variances. Such variances, calling for management by exception, might be supported by analyses provided by the computer for management study and decision. The cost system in a computer could likewise provide supplementary data, such as (1) quick computation of cost estimates for bids and price quotations and (2) inventory and cost of sales figures.

Then there is the possibility of applications to forecast. In the past, most emphasis on reports for management has been on historical data, and yet forecasting and budgeting have long been used as efficient tools of modern management. An instance is financial forecasting used very effectively by a tobacco manufacturing firm with a large number of decentralized units. Projections covering a one-year period were prepared every three months by each operating unit. Each projection included two basic forecasts: (1) one showing estimated sales, production costs and other expenses, with the resulting estimated gain or loss for the period and (2) another showing estimated cash revenues (from sales, loans, etc.) and cash payments, for such items as raw materials, labor, plant and equipment, dividends, and loan repayments. At the end of each quarter a comparison was made between actual and estimated performance for the three-month period. In between these quarterly reports, a new forecast might be prepared, in the event of some unusual occurrence changing a basic factor in the overall picture. Likewise, in the case of long range projects, such as large plant additions, the usual one-year forecast could be extended to cover a three to five-year period. If electronic equipment could be properly programmed, the resulting forecast information could be produced much more easily and rapidly. Furthermore, in the event of changes in one or more of the factors going into a projection, a new forecast could be run off on the equipment with very little time and effort.

No doubt electronic equipment will provide better and more timely forecasts of this nature. However, results will, none the less, be estimated, and may be subject to wide margins of error. It is true that electronic computers can be instructed to arrive at a logical conclusion on the basis of data fed into the machine. However, a sales or financial forecast is not the same thing as production scheduling. The latter involves scheduling actual orders on hand for processing on a given capacity of plant and equipment and labor within a given period of time. Among other things, sales forecasting involves such factors as estimated gross national product, estimated population, estimated price levels, estimated reaction to advertising campaigns, estimated actions of competitors and estimated customer reaction to style changes. While the elec-

tronic computer does arrive at its answers logically, its conclusions can be no more accurate than the premises on which the conclusions are based.

Nevertheless, in spite of the risks of predicting the future, whether by crystal ball, tea leaves, or elaborate forecasts prepared manually or by electronic equipment, we can conclude that the electronic computer can prepare projections faster and better. Also, corrections may be made much more easily and promptly. Future production and labor requirements follow the trends set by the sales estimate. We have already touched briefly on the use of the equipment in production control. The forecast of labor requirements is not any less important in these days of emphasis on labor relations. Given a level of production, the labor on each product must be analyzed by operation so that the total labor requirements may be determined. A breakdown by periods has to be determined well in advance. Using manual methods, it was difficult to prepare accurate and flexible estimates of this nature. With electronic equipment, is should be possible to produce rapid and flexible estimates.

Certain other kinds of reports for management have frequently been too costly and bulky to prepare conveniently under manual or punched-card methods. These include profits on sales mix, passing break-even point, daily reports on sales, production, labor, etc. Perhaps now, with electronic equipment, they will become practicable.

There may also be an area of application in connection with operations research. Most business problems cannot be put into a test tube to produce a decision, but there are certain decisions in business management which are directly dependent upon facts and logical relationships. Operations research attempts to reduce business problems to quantities which can be measured. Observation, experiment, and mathematics are then used to analyze the resulting relationhips. In this area, electronic computers may be used to arrive at a more scientific method of making decisions.

Closely related to operations research is a new computer application called "simulation and risk studies." A theoretical "model" of the problem being studied may be "built" inside the computer and the model may be subjected to various tests. Certain weaknesses may thus be pointed out even before a real or physical model is constructed. The new design of a jet plane, for example, may be put into the computer and studied before any time and expense are spent in building actual test models. Similar testing methods may be used in checking the design of an industrial machine, the distribution system of a public utility, the risk of investing capital in new equipment, and the selection of the best location for new factories or retail outlets.

Effects of EDP:

What may be the effects of electronic computers, particularly in regard to management organization? There will be greater coordination of the three principal management functions—production, sales, and accounting. Then, too, the issue of centralization vs. decentralization of multiple-plant operations is sharpened. Because of the high cost of electronic equipment, only a high volume of data handling is economical. To achieve volume, uniform methods of reporting from branch plants and divisions would normally be necessary for efficient handling of electronic equipment. Therefore, companies which have centralized management or centralized data processing departments are ideally situated from an organizational standpoint for the utilization of such a system.

Does this mean that presently independent divisions or branches will be forced to centralize. Not necessarily. The advantages of decentralization still exist and will continue to provide management with a free and concentrated control of a particular segment of the business. Decentralized management can still devote all of its intelligence and judgment to the solution of problems of the particular unit. True, when electronic equipment is adopted, uniform reporting will more than likely be necessary and data processing may have to be centralized. However, if the management of branch plants can promptly receive the facts it wants, location and organization of the data processing department is unimportant. In other words, you can still have decentralized management with centralized data processing.

One example of centralized data processing serving decentralized management is Sylvania Electric Corporation. This company established a data processing center to serve several dozen plants in all sections of the country. The location of the center was not to be determined by production factors but by the information and communication needs of the company.

Although the center concentrated the data processing operation at one location, it did not change the other organizational relationships of the company. The main objective was to supply managers with information more promptly in order to keep in the competitive picture. Previously, managers were able to postpone taking action because of the lack of information or because of the delay in getting necessary data. Now, the test of a manager's analytic judgment will be whether or not he is able to formulate request for the particular sets of data that are pertinent for the decision. The information upon which to base decisions can be readily available, and there will be much less of an excuse for management to procrastinate.

With all the claims made for electronic equipment and in spite of the efficiency the computers have provided in many businesses, the picture would not be complete without a look at their limitations. Human intelligence organizes and plans the work to be done by the machine and tells the equipment exactly what to do. The latter merely supplies speed, accuracy, and flexibility in doing the job. The machine is still just a tool to do man's work more cheaply and more efficiently. Man still holds the responsibility of application and the decision of what to accomplish and how it is to be accomplished. Men can think. The machine is still a robot and will operate only under the instructions of man.

A Decision Required

Although the electronic computer will never write the sequel to *Gone with the Wind,* there is no doubt that the development of the computer has created new opportunities for management planning and control. The advent of electronic data processing has brought about what might be called the industrial revolution in the office and in management techniques, and the era of the older, slower, and more conservative methods will soon be as outmoded as a Chinese mandarin operating an abacus at General Electric's Appliance Park. Each man among the industrial accountants will have to make his own decision whether he wants to move ahead with E.D.P. or whether he wants to leave it to others and fall by the wayside. Each man faces a decision, and few of us can afford to ignore the challenge of the new methods.

B—E Charts Reflecting Learning

by RONALD BRENNECK*

ONE VERY IMPORTANT ASPECT not covered in authors discussion of break-even charts, is the effect of the learning curve on the variable cost per unit for any product requiring this type of analysis. Although there is usually one unit selling price for any given contract or product, the variable cost for most products indicates some rate of improvement as the total quantity of units produced increases. While, in highly mechanized industries, this rate of improvement is small, others, such as aircraft manufacturers, show as much as a 30 per cent reduction in variable cost when the production quantity is doubled. Consequently, the point at which a program or plant will break-even is influenced considerably by the rate of improvement for the individual product.

The effect of the learning curve on the break-even point is difficult, if not impossible, to show on the conventional break-even charts. I am of the opinion that a break-even analysis of any product requiring repetitive operations can be best prepared and utilized through the use of logarithmic scales. (It should be noted that either quantity to be produced or per cent of plant capacity can be portrayed in this manner.) For the illustration in Exhibit 1, the following data was used.

Unit sales price	$100
Fixed cost	200
Variable Cost Unit No. 1	$50
Product rate of improvement	80%

The plotting of the fixed cost line and the sales income line would be done in the same manner as in conventional break-even charts. The variable cost line would

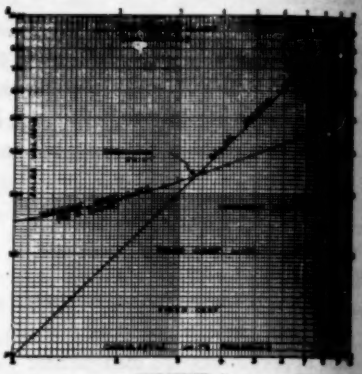

EXHIBIT 1

be arrived at in a different way from the conventional chart. Based on a variable cost of the first unit produced of $50, on an 80 per cent learning curve, the points necessary to plot the variable cost line would be derived as follows:

Unit no.	*Unit variable cost based on 80% learning curve*	*Cumulative variable cost*	*Add fixed cost*	*Total cumulative cost (variable cost line)*
1	$50	$50	$200	$250
2	40	90	200	290
3	36	126	200	326
4	32	158	200	358

When the variable cost line is plotted on the logarithmic scale, the intersection of the variable cost line with the sales income line indicates that the break-even point of a contract basis would be at Unit 4.

In conclusion, I feel that this type of break-even analysis, as well as other forms, is an important contribution to managements "bag of tools" in controlling profits.

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Organizing An Analysis Service in the Controller's Department

by HAROLD W. FOX

A CONTROVERSIAL ISSUE among professional managers is the place of an internal consulting service known variously as financial analysis, commercial research, management audit or similar titles. Understandably, operating executives can be quite vehement in their reactions to reports on their activities circulated among the top echelon. Why should there be such a service? Where on the organization chart does it fit? What does the analyst do? What are his qualifications? How about supervision, administration and functional place of the service? These are some of the questions which accountants and others have frequently asked the author. It is hoped that this article will stimulate additional discussion about the responsible administration of an analysis service.

Broadly, the purpose of such a service is to facilitate decision-making by relieving management of the time-consuming tasks of investigating and interpreting complex business relationships. The analyst compiles that information relevant to a problem which a business manager would secure himself if he had the time. Completed staff work means that the content, timing, and form of the report furnish the manager what he needs to know about a problem so that he can apply his judgment.

Illustrative Problems: Cash Flow, Product Margins

Cash flow is an example which primarily affects balance sheet accounts. Taking the cash balance on hand at the beginning of an accounting period as the starting point of a cycle, the analyst will prepare schedules by due dates of receivables and payables (allowing for current sales orders and purchase commitments) to forecast the ending balance. If at the close of the period there is a variance because, say, of insufficient cash receipts, the investigation would lead beyond the accounts into operational areas. The analyst would check the

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administration of receivables from the time of shipment until liquidation. The cash stringency may be attributable to billing errors or to a low rate of collections. The next step would be to probe into the control over invoicing, the feasibility of assigning receivables, and the selectivity used in extending credit.

The analyst's report will pinpoint the problem and the probable consequences of various solutions. Should the personnel and procedures in the collection department be strengthened? Would it be more practical to factor the accounts? How about instituting cash discount terms? How much faster would cash be received under each of the above changes? What are the probable effects on sales if a new method is adopted? What are the different incremental costs? The analyst's contribution, in this simplified example, has been to identify the cause of the problem in a dispassionate manner and to present to management the choice of leaving matters in *status quo* or adopting any of several proposed remedies.

Distribution cost analysis is a project which primarily affects operating statement accounts. The aim may be to determine how much each product contributes towards residual costs and profits. Given the variable gross profit (net sales minus variable manufacturing costs) for each product, the analyst will proceed to segregate the avoidable selling, administrative, and other expenses under order-getting functions, such as direct selling, sales promotion, etc., and, under order-filling functions, such as invoicing, collections, etc.

The determination of whether a cost is avoidable, i. e., would cease if volume declined, or residual, i. e., is fixed in the short run, is often one for management alone to make. The analyst will classify commission (at a fixed rate on sales) as an avoidable expense. Salesmen's salary is different. A scatter diagram or least squares calculation of expense versus sales amounts shows management's actions in the past only, possibly on the basis of inadequate data. (Next time, management may add to the sales force to counter a drop in bookings). A forward-looking analysis requires the managerial determination of the rates at which avoidable costs contract and increase with changes in business conditions, and of the business levels at which the various residual costs become avoidable. In other words, one result of the determination should be a framework for orderly retrenchment and expansion with respect to expense administration of the entire business.

After accumulating the avoidable costs in functional cost centers, the analyst will prorate the latter to products on relevant bases of allocation. For example, the cost of the invoicing function may be derived on the basis of number of invoices or invoice lines for each product.

All the expenses charged to a product in this analysis are subtracted from its

variable gross profit to find the product's contribution margin. Profitability ratios, such as contribution on funds employed and incremental unit profit, may be incorporated into the report along with the product statement. The analyst will be careful to point out the assumptions used in processing the data and their limitation in a dynamic business setting. His contribution has been to provide information useful for sales tactics, pricing under state "unfair practices" acts, and decisions for retiring unprofitable items from the line.

The purpose of the exploration dictates its comprehensiveness. For example, for price-setting purposes the analyst would supply estimates of the sales volume and price history of own and directly competing products. Related factors such as quality difference, population growth, and advertising expenditure would be considered. His interpretation will discuss the product's profit leverage, the historical relationship of prices within the industry, the apparent sales potential, and the elasticity of demand, to assess the probable impact of different price-setting proposals. A different emphasis would be in order for a cost study (as opposed to a price study). For this purpose, the unit cost of securing an order and processing a shipment would come under review. Alternative channels of distribution, warehousing methods, and accounting procedures would be compared. Practicality and pertinence are the only limits of an inquiry's scope.

Controller's Area as the Analyst's Base—And Some Reservations

One view favors the installation of the analysis activity under the supervision of the controller. Organizationally, it may be desirable to build into the present corporate growth trend a continuing balance among the three major business departments. Production moves towards a greater degree of automation, sales towards marketing, and the financial area towards management services.

But, could, perhaps, the analyst serve more effectively as a representative of the sales or production department? Undoubtedly there are many occasions when an insider can develop data more quickly and informedly than a staff man from a different department. On the other hand, the assignment of an analyst within an operational department could tend to constrict his scope and, instead of general business analysis with an overall point of view, orient his activities more specifically towards his area's interests. An outgrowth could be separate analysis sections in productions and sales, with liaison between them, as well as between each and accounting. This seems a costly and cumbersome structure. And who outside the controller's area should supervise

the analyst? He could hardly report to a member of middle management such as the production control manager. This executive might lack the status to resolve conflicting demands on the analyst's time, etc. Yet a slot under a vice-president could defeat the main purpose of the service. The analyst is supposed to help conserve the vice-president's time, not to add to his supervisory obligations.

Furthermore, there is the other very practical consideration of centralizing figures work where the source data and mechanical facilities are available. The analyst needs both operational and accounting information. He secures the former mainly from interviews and observations and the latter from reclassification of data. In the aforementioned cash flow project, the analyst would discuss present and alternative collection methods with the credit manager. The analyst would see for himself in what manner the department functions. He would use the department's cost reports as a basis for estimating the costs of different methods.

Ordinarily, people can communicate better than figures. The analyst's integration into the controller's area will furnish him with continuing knowledge of the company's accounting system and treatment so that the figures can communicate to him as well as people do. The controller makes the analyst available to serve top management or operating executives as needed.

Some reservations may be in order. Controllers do not necessarily welcome the responsibility of forwarding reports in which accounting data are only one of the elements, often quite unrecognizable at that. There is concern that the hard-won respect for statements prepared in accordance with generally accepted accounting principles may be jeopardized. Another danger arises from separating line from functional authority as happens when a man from the financial area receives instructions from and makes informal reports to operating executives. The credit manager may take exception to the recital of collection procedures or the sales manager may object to examples in the analyst's report describing the support which salesmen give the credit department. The sales manager could instruct the analyst to complete an urgently required project on territorial quotas at the same time that the controller assigns priority to the cash problem. There is a real possibility of conflict over the reports—and over the reporter.

Right now, the reader may be thinking of his own business environment, and other considerations will occur to him. The intention has been merely to suggest that institution of an analytical service has many ramifications. Planning and control are as necessary here as in other business activities. Even on a simple job, the analyst may find himself physically as well as philosophically removed

from the accounting department. This is evident from the illustration which follows.

Range of Analytical Investigations

Frequently, the nature of assignments dictates a high degree of interdepartmental mobility. The determination of economic lot sizes in materials purchases entails, for example, the designing of the investigation (with materials control), tabulation of exploded bills of material providing for the substitution for obsolete material (with engineering), projection to the production forecast (with production planning), provision for the longer-range sales outlook (with director of marketing), categorization by value and potential quantity discounts and also lead times (with purchasing), application to specific production runs (with scheduling), inspection of storage and transportation facilities (with stores and traffic), calculation of spoilage, shrinkage allowances, and also materials handling costs, inspection costs, etc. (with cost accounting), imputation or computation of rent, interest, taxes, insurance, capital usage formulas, etc. (with financial accounting); etc., etc. His quest for information keeps the analyst moving to the affected areas until he has the background for presenting a comprehensive report on and interpretation of the problem. He secures technical advice as needed but minimizes the impositions on the time of operating personnel.

His final report may spell out a plan which, on the basis of probability theory, will result in the lowest expected out-of-pocket costs to the business. Perhaps this is the system which management should and will implement. But the report will reflect also the analyst's exposure to some of the non-numerical factors. He may, for example, cite the effect on morale if the line is down due to lack of materials and no incentive can be earned, and may contrast the cost of decreasing the risk of exhausting materials, i. e., buying in larger quantities, with the benefit of maintaining good labor relations. Presumably, management will be interested in these comments, too.

Getting the Function Started

It may be useful to distinguish between a situation in which top management is pressing for an analytical service and one in which the initiative emanates elsewhere. Here again, as in the rest of this article, the illustrations and alternatives are merely suggestive of various methods. There is no intention to expound the view that one particular course of action is preferable over an-

other. Fundamentally, support and use by management of the consulting service are its means and ends, respectively. Hence, it is much easier to launch the function in answer to a top level request than in anticipation of a top level requirement. At management staff meetings the members may agree on the need for systematic attention to economic surveys, merger proposals, sales trends, forecasts and profit plans, productivity studies, break-even point analysis, make-or-buy questions, and other investigations. Having identified the areas of immediate concern, the top echelon may debate which area is best equipped to organize an internal consulting service. After considering pros and cons such as those mentioned earlier in this article, the group may decide that staffing and administration should be handled by the controller.

In this case it will be assumed that the staff choice is an experienced analyst from the outside. This man should offer a background of working with executives and of applying managerial accounting techniques. Knowing the merits and pitfalls of the work, he can help chart the progress of the service to optimize the company's benefits. The personal and business qualities customarily required for other responsible jobs below the controller's level are basic to the program's success. Specific qualifications suggest themselves from a review of the analyst's functions.

The analyst should be a generalist-in-depth. One part of his job is to size up business situations prudently. Hence he must deal effectively with people and figures and grasp operational functions and problems. The other part is putting the findings across to management. Hence he requires broad perspective to ferret out the possible opportunities (solutions, tactics) with their likely rewards and risks, and summarize these choices in relation to total business impact. The form of presentation of the results of the work should be the one which the front office considers the most meaningful. Some presidents abhor figures and love graphs; some prefer a narrative style. Familiarity with different methods of presentation is not enough; the analyst actually needs close rapport with top management. To summarize:

1. The analyst should meet the company's standards for middle management.
2. He should know business principles as an auditor knows accounting principles.
3. He should be able to project himself into management's position.

The foresighted controller will select likely candidates with the first qualification for screening by operating executives for the second and leave the decision on the third qualification to top management. Incidentally, this procedure

should lay the groundwork for subsequent cooperation to make the program work.

A somewhat different course of action may be appropriate if top management does not sponsor this service. An analytical program may be the extension of assistance which the financial area furnishes operating executives with budgets, quantitative evaluations, pricing studies, and the like. Executives may request the designation of a person (for continuity) and the by-passing of channels (for convenience)—and a consulting service is under way. Or the start of a new section may represent an effort by the controller to strengthen the business. Among the prospective benefits are:

1. Improvement in inter-departmental communications.
2. Availability of an objective overall company viewpoint before executives make decisions.
3. Relief of operating men from financial work without the burden of supervising.
4. Assessment of ideas before much time and money are invested.
5. Development of personnel for greater responsibility.

In this case, it will be assumed that the choice is promotion from within. Either an operations-minded accountant or a man with operating background and a flair for analysis may serve. The advantage here is that assignments can be rotated to find the man with the greatest interest and resourcefulness. Further, the employee can utilize his knowledge of the company. The program can be expanded gradually as the incumbent masters his new duties. The controller schedules any required indoctrination into the functions performed in the different areas and into the application of managerial accounting techniques. If the program should be discontinued, it may be easier to transfer the old employee than a newcomer.

Analysis In Action

For the sake of simplification, this article speaks of a single analyst. In practice, a service section often comprises a group of analysts with clerical support and a manager. The procedures outlined here have a large installation in mind. The forms are illustrative.

Concurrently with determining the program's scope and staffing, the controller will outline its administration. The relationship of the analyst to other personnel inside and outside the controller's area must be clarified. Ordinarily, analysis work will be coordinated with the systems work. Perhaps the analyst

should work directly with any executive on technical matters pertaining to the analyst's assignments. For example, the analyst might report a product's share-of-the-market trends directly to the product manager in the marketing department. Policy matters, on the other hand, must be handled through the ordinary channels. The product manager may want the analyst to conduct a survey among consumers in order to secure additional information on the product's acceptance. If this function is outside the scope of the analyst's customary activity, the product manager needs clearance through channels before the scheduling of such an assignment can be discussed.

The work should be described, including the important restriction that the analyst does not participate in operational decision-making. Analysis should be the incumbent's primary responsibility. If the analyst assists with the periodical closing of the books or is parceled out to help meet various emergencies in operating departments, there may never be time for a productive analytical activity.

The controller should monitor the service right from the start. He and the executives concerned select the projects and settle the scheduling. At a later date, the analyst may represent the controller as coordinator, furnishing him a copy of a time schedule such as Exhibit 1. Either way, the controller's area disseminates the approved time schedule and amendments. One consolidated time schedule for the entire section should be issued if two or more analysts work in one particular area. In some companies, individual notifications pertaining only to the recipient department may be preferred over a master schedule. It is important that the analyst's work in related departments be cleared with those departments.

ANALYSTS TIME SCHEDULE

Analyst's Name

May, 1959
Month

Project No.	Executive Concerned	Assignments	Approximate Dates	Estimated Hours	
				Analyst	Clerks
30	Mr. Product Manager	Sales forecast and September Quarter, 1959, profit plan, Product "R"	5/6 - 5/11	32	36
31	Mr. Materials Control	Economic lot sizes and re-ordering points	5/12-5/14 5/19-5/20, open	70	200
32	Mr. Production Engineer	Make or buy, Assembly "X"	5/15-5/18	16	None

EXHIBIT 1

The analyst furnishes the controller with a copy of every written report and apprises him through a note of oral reports and of information which may concern him. The controller attaches these reports to the activity summary (Exhibit 2) which the analyst submits weekly. The activity summary is a preprinted sheet with space for the date, analyst's name, and separate lines for

ACTIVITY SUMMARY — Analyst's Name — 5/18-22, 1959 — Date

Project Number	Brief Description of Work Performed This Week		Actual Hours This Week	Actual Hours To Date	Estimated Total Hours	Estimated Per cent Completed
31	Grouped items by unit cost, yearly quantity, total value. Saw Mr. Purchasing Agent re quantity discounts; Mr. Production Manager re mfg. schedules	Analyst	16	40	70	60%
		Clerks	60	120	200	
		Analyst	8	16	16	100%
32	Computed mfg. costs; located available capacity	Clerks	none	5	none	

EXHIBIT 2

each project in progress. On the project lines, there is a column each for identification number, brief description of week's work, weekly hours, cumulative hours, estimated hours per time schedule, and estimated percentage of completion. Time information for clerical assistance is shown directly below the analyst's time. At the bottom of the activity summary is space for comments. The analyst notes here any action by management based in large measure upon his work, also any deadlines or schedules missed, etc.

Every accounting period or quarter, he recapitulates the activity summaries on the same form as Exhibit 2. The recapitulation lists identification number and name of all projects completed in the interim, with total actual and estimated time spent on each. The actual time total for all of these projects applicable to prior periods is subtracted. The total time spent during the period on projects not yet completed is added, and the grand total represents the analyst's active time during the period. Tangible results and variances are noted in a comments box provided at the bottom of the complete form.

The activity summary is useful for information and control purposes. Operating executives know that any time they wish to discuss a project with the controller, he has recent information on the type and amount of work performed to date and estimated percentage of completion. The activity summary should signal the need for action by the controller if one project takes a disproportionate amount of time to the detriment of other scheduled assignments. The summary could also serve as the starting point for securing the user's appraisal of the individual analyst or the entire program.

The recapitulation is a sharper tool for appraisal. It could be expanded to include cost information for comparative purposes or for inter-departmental transfers. Another use is for following through. The controller can determine to what extent the analyst's work is put to use, and whether his interpretations stand the test of time. Perhaps substantial benefits materialized from managerial action on conditions which analysis revealed. Or new developments may dictate the resumption of a project from a different point of vantage.

Reporting the Findings

Although the control procedure described above applies only to fairly large organizations with large analytical staffs, the concept of a controller's analysis section could serve effectively in many companies above the size where all administrative and executive functions are combined. The analytical contribution will be heaviest in a harmonious atmosphere, in which impartial inquiry is valued above imperative intuition.

The analyst must resist any temptation to solve partly intangible problems through arbitrary formulas or to apply hindsight for interpreting actions taken in the face of uncertainty. For example, a study may show that, during a certain television campaign, a product's sales rose, whereas they stabilized after a shift to other media. Even though the correlation is statistically significant and the television program's popularity is borne out by consumer surveys, the analyst must be mindful that he is describing a specific case covering a particular span of time. To date the question of how to measure the effectiveness of advertising has not been resolved. And a conclusion that the rise in sales would have continued if the television effort had been maintained is probably not tenable. Finally, the analyst may not give in to any pressure to exaggerate or expurgate his findings. If he distorts facts, the analyst's function ceases to be a constructive one.

To summarize, a properly organized, well functioning analysis service can be a strategic asset to enlightened business management. It is the financial area's opportunity to provide the factual support which management requires in this era of increasing complexities. This responsibility should be assumed with due regard to the repercussions which an analysis service might generate.

Inventory Accounting in Strip Mining of Coal

by ROBERT K. MOORE

IN THE COAL INDUSTRY, profit-making has been increasingly difficult, due to the reduced realization experienced in the face of constantly increasing costs. Decrease in cost has been accomplished by utilization of more modern and efficient mining machinery which, in turn, has involved considerable capital outlay. The trend is toward much larger equipment and mechanization in all phases and types of mining. The constantly smaller revenues from sales cause the control of costs of the various processes involved to become more critically important. Accounting for costs in strip mining is probably unique. Coal delivered to a customer must be uniform and suitable for that particular customer's use. This involves sizing, mixing, cleaning and treating the coal so that the most efficient results may be obtained in each case. The specific processes can probably be best broken down into these categories:

1. Mining—The actual removal of the mineral from the earth.
2. Hauling—Transporting the coal from the field to the preparation plant.
3. Preparation—Sizing, mixing, cleaning and treating the coal to specifications.
4. Sale—Disposition of the product, itself.

An appraisal of any one of these costs processes would be too lengthy for this paper. Consequently, I will confine myself to the single problem of accounting for inventory. Inventories discussed are of three kinds: (1) repair parts and supplies, (2) coal stripped and (3) coal drilled and blasted.

Parts and Supplies Accounting Procedure

As to the first, the increase in mining efficiency has been accompanied by the advent of huge stripping units costing millions of dollars and other relatively expensive equipment, such as enormous haulage trucks, graders, dozers and other mobile equipment. Keeping a record of the myriad of parts, from nuts and bolts costing a few cents apiece to "buckets" and "sticks" costing thousands of dollars each, is no small problem. We have one control account entitled "inventory—repair parts and supplies." Through this account any transaction

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of any nature affecting the mining costs is routed. Every item, no matter how large or small, is charged to this account and, subsequently, charged out to the appropriate expense or capital account.

To follow the procedure from its inception, we must begin with the original requisition for material. When any item is required at the mine, whether it is stationery, repair parts or a piece of capital equipment, a purchase order is prepared in triplicate. Prior to requisitioning a capital item or any item in excess of $500, a request for appropriation is required, with signatures of designated superintendents and officers. The original purchase order is forwarded to the vendor, one copy is sent to the home office and the second copy is retained in the open file at the mine office. Subsequently, upon receipt of material at the mine, a receiving slip is prepared in duplicate. One copy is used as reference for posting to the card file maintained on all repair parts and supplies and then attached to the appropriate purchase order. The original receiving slip is forwarded to the home office to be attached to its copy of the voucher prepared in payment of the charge, after notation of the receipt has been made on its copy of the purchase order.

Invoices are requested in triplicate from all vendors. Upon receipt of the invoice in the home office, the original and one copy are processed in the usual manner by verification of footings and the extensions. An account distribution stamp is affixed to the original invoice and the charge is coded to the inventory-repair parts and supplies. After posting to the invoice register, the original and first copy of the invoice are forwarded to the purchasing department for verification of the price, material receipt and authorization for payment. The first copy is retained in the purchasing department and attached to the appropriate purchase order. If shipment has been completed on the order, the purchase order together with the attached invoice copies are then filed in the completed order file. The original invoice is returned to the accounts payable unit for payment. Meanwhile, the second copy of the invoice is forwarded to the mine office where the price is entered on the card file. The invoice is then matched with the purchase order and receiving slips and filed in the completed order file.

As materials are requested each day, material issue slips are prepared for each transaction, indicating the part number, item, quantity, dollar value and account charged. These slips are then posted in the card files. Semi-monthly material issue recapitulation sheets are prepared. These simply recapitulate by account number in chronological order all items and their dollar value charged out during the particular period. The account charged may be an expense account, a receivable account or a capital construction-in-progress account. The

sheets are accumulated and forwarded to the home office where their arithmetical accuracy is verified. A journal entry is prepared relieving the inventory-repair parts and supplies account and distributing the offsetting charges.

It may be well to note that items such as stationery and office supplies, being of a nominal amount, are immediately expensed on the material issue sheets upon receipt of the material. Items returned for credit are also entered on the material issue sheets as a charge to accounts receivable. Credit or payment, when received in the home office, is coded directly to the accounts receivable account. As a further step in control, a photo-copy of our invoice register sheet is mailed each week to the mine operation. This enables the mine office to verify items charged to its account and to keep an accurate check on the materials received but not invoiced or materials invoiced but not received. A partial inventory of repair parts and supplies is taken each month and the customary annual physical inventory follows in order.

Acquisition of Coal Lands

A corporation cannot engage in strip mining unless it has the coal lands to strip. Acquiring these lands or the right to strip the minerals on it is an expensive and time-consuming task. In the stripping process, it is essential that sufficient coal reserve be maintained to supply demands for years to come. For economical reasons, coal reserves must be located immediately adjacent to coal presently being mined in order to allow a continuous stripping process. It would not be feasible to attempt strip-mining in a haphazard manner, jumping from one section of land to another. The cost of moving the machinery alone would be exorbitant.

Coal lands are either purchased in fee or permission is obtained to remove the coal from the land for a flat purchase price or on a royalty basis of so much per ton of coal removed and sold. Acquisition of these rights can become quite involved. The usual procedure is to obtain an option to purchase the land after a given period of time during which the company is granted permission to sink various test holes to verify the existence of the coal on the property. This is necessary, not only to confirm the preliminary estimates of the engineers but also to ascertain whether or not the coal may have previously been mined by underground methods. After the legal phases and prospect drilling have been accomplished to the satisfaction of the operator, the option is either exercised or dropped, as the case may be. Needless to say, this preliminary phase of the operation is highly important. The availability of the coal in quantities which can be economically mined and sold to meet the qualifications of the customer

is the determining factor, although necessity may occasionally dictate the purchase of land in order to maintain access to a stripping operation.

Maintaining an accurate check on our inventory of coal stripped and coal drilled and blasted is not nearly as simple as maintaining an inventory of repair parts and supplies. It may not be common knowledge that a seam of coal being removed may lie quite a distance below the surface of the earth. The overburden encountered in United States stripping operations averages more than 41 feet in depth and it is said that "enough overburden is removed to fill up the Panama Canal five times a year." *Bituminous Coal Facts,* National Coal Association, 1958. Considerable costs are involved in making this seam of coal accessible for the loading crews. The overburden, if of a particularly rocky nature, may involve extensive "shooting" or drilling and blasting. This procedure, followed by the stripping process, is necessary to expose the coal seam before it can be loaded into the haulage trucks and transported to the preparation plant.

Coal Inventory Computation and Valuation

Determining the valuation of the inventory of coal drilled and blasted and the inventory of coal stripped involves considerable time and effort. Briefly, the engineers survey the affected areas at the end of each month and, by reference to their maps and their knowledge of the thickness of the particular coal seam and the percentage of recoverable tonnage, are able to report the inventory in tons of coal drilled and blasted and the inventory of coal stripped. An adequate inventory of coal stripped is of prime importance at all times.

Determining the inventory valuation is really a three-stage problem. From routine mine reports, we are able to determine the amount of raw coal hauled to the preparation plant during the month. Our shipping weights indicate the amount of "clean coal" sold, and the resulting reject tonnage can be calculated by subtracting the latter figure from the former. By taking our ending inventory of coal on track and adding the coal sold during the month, and deducting the beginning inventory of coal on track, we arrive at the coal produced in any given month, as follows:

TONNAGE COMPUTATION

	Tons	*Amount*	*Per ton*
Ending inventory — Coal on track.....	25,000	$ 118,750	$4.75
Add: Sales for the month.....	200,000	1,000,000	5.00
Coal available during the month....	225,000	$1,118,750	$4.97

Less: Beginning inventory	20,000	102,000	5.10
Coal produced during the month	205,000	$1,016,750	$4.96

Our second step is to determine the tons of coal uncovered and the tons of coal drilled and blasted each month. By applying the reject percentage previously determined to the inventory of coal uncovered *at the end of the month*, we arrive at the inventory of clean coal uncovered. We then add to this the production tonnage and deduct the inventory of coal uncovered at the beginning of the month. The resulting figure is the total coal uncovered during the month:

COMPUTATION OF COAL UNCOVERED

	Tonnage
Inventory — Coal uncovered, end of the month	100,000
Less: Reject percentage (10%)	10,000
Inventory "clean coal" uncovered, end of month	90,000
Add: Production during the month	205,000
Tons available	295,000
Less: Inventory "clean coal" uncovered, beginning of the month	150,000
Coal uncovered during the month	145,000

In a like manner, we determine the amount of coal drilled and blasted during the month. By adding to the inventory of "clean coal" drilled and blasted the tons uncovered (as previously calculated), and deducting the inventory of coal drilled and blasted at the beginning of the month, we have the coal drilled and blasted during the month.

COMPUTATION OF COAL DRILLED AND BLASTED

	Tons
Inventory — Coal drilled and blasted, end of the month	80,000
Less: Reject percentage	8,000
Inventory—"clean coal" drilled and blasted, end of month	72,000
Add: Coal uncovered during month	145,000
Total available	217,000
Less: Inventory, coal drilled and blasted, beginning of the month	75,000
Coal drilled and blasted during the month	142,000

Having determined these tonnages, we are now ready to make our adjustment for the month. Of course, tonnage without costs would be useless. We maintain a "mining cost book" in which all expense accounts are broken down into the particular process. The cost applicable to the specific processes (drilling

and blasting and stripping) are applied to the appropriate tonnages as computed and added to the known beginning inventory of both tonnage and dollar value. We then arrive at the tons available and the related cost, which gives us an average cost per ton. This average cost is used in pricing the ending inventory. We then "back into" the cost of the tons uncovered during the current month. We arrive at the cost of the coal-stripped inventory during the current month in a similar way except that, in determining the applicable cost, we must also include the drilled and blasted cost of the tons uncovered as previously computed. This may be more readily understood by viewing the following table:

ADJUSTMENT OF COAL-STRIPPED INVENTORY
& DRILLED AND BLASTED INVENTORY

	Tonnage	*Amount*	*Cost Per Ton*
Coal drilled and blasted adjustment			
Inventory — Beginning of month.....	75,000	$ 37,500	$ .5000
Drilled and blasted — Current month..	142,000	63,900	.4500
Tons available	217,000	$101,400	$ .4673
Tons uncovered — Current month....	145,000	67,755	.4673
Inventory — End of month	72,000	$ 33,645	$ .4673
Coal stripped adjustment			
Inventory — Beginning of month.....	150,000	$225,000	$1.500
Tons uncovered	145,000	100,000	
Drilled and blasted — Cost of tons uncovered	———	67,755	1.157
Tons available		$392,755	$1.331
Tons produced		272,965	1.331
Inventory — End of month.....		$119,790	$1.331

After determining the inventories of coal drilled and blasted and coal stripped, as of a given date, it is a simple matter to adjust the inventory account to the correct valuation.

Conclusion

Yes! Coal mining methods have made great strides from the time of the pick and shovel. It is a continual challenge for everyone in the accounting field to keep abreast of the current changes and to assist management to accurately analyze the present and forecast the future in its efforts to obtain that good clear profit picture.

Steps in Achieving Control of Material On An Electric Computer

by H. WARREN WHITE

CONSIDERABLE MATERIAL is being written today concerning the importance of inventory control, and much is frequently made of the possibilities which exist through the use of electronic data processing equipment in this area. The excitement which surrounds electronic data processing equipment as applied to material control is manifesting itself in a tangible form at Lockheed. The old system of tediously reviewing manually maintained records on a cyclical basis, to select those items for which procurement action is required, is gradually being replaced by a new type of material control based on the application of the well-known principle of control by exception.

Through the use of a large-scale general-purpose computer, it is now possible to produce action documents highlighting those specific items in the inventory which are in need of attention. The span required for initiating procurement action to support a new manufacturing program has been considerably reduced, thus providing opportunities for more economical purchasing action. The problem of handling peak loads has been eliminated. The investment in inventory has been substantially reduced. The implementation of procurement policies is now administered through machine summarization of details, rather than reliance on human compilation and judgment. The number of stock-outs caused by improper or untimely manual procurement analysis has also been reduced.

The basic principles involved call for providing the data processing center with all the elements of input necessary for the determination of procurement action. We have now reached what might be described as the halfway point. The basic requirements are fed into the computer, along with machine sensible (punched card) recordings of orders, receipts, and disbursements, so as to make possible the automatic selection of items which require either additional procurement action or disposal as surplus. The actual scheduling of the procurement document, including considerations necessary for economical ordering

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quantity, price breaks, inventory level, etc., is still being handled manually. But it is no longer necessary to laboriously search through thousands of ledgers to select those items which require action.

Before describing the present system it would be well to give consideration to the basic operations involved in a material control system. These operations are applicable whether performed manually, via punched card equipment, or on an electronic data processing machine. In order to serve the broadest areas of interest, an effort has been made to convey the basic principles of material control as we have applied them, without excessive involvement in the maze of detail, sub-routines, exception loops, alternate routes, short-cut systems, etc., which are typical of the field. Exhibit 1 depicts the basic procurement operations necessary to the material control function, broken down into the basic elements of input, action, and output.

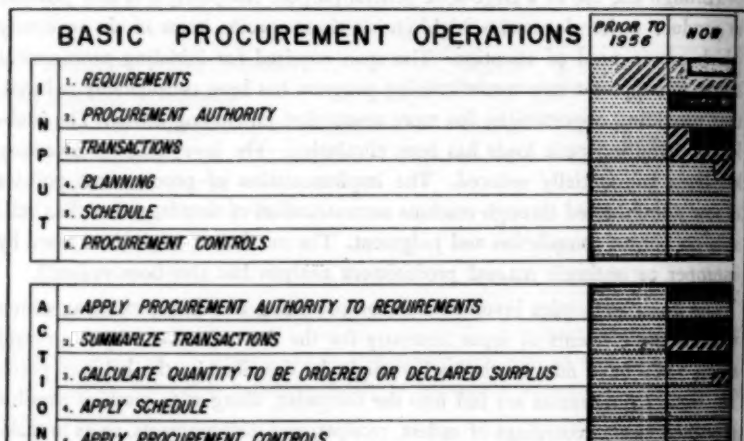


EXHIBIT 1

Elements of Input in Material Control

The first element of input comprises requirements, i.e. the breakdown of types and quantities of materials and parts necessary to build each end-product. This is introduced in the form of punched cards which specify the use of each detail part required to build either a complete airplane or a spare assembly. Requirements for purchased parts are fed in directly. Requirements for manufactured parts are matched against raw material conversion files and used for summarization of raw material needs. Such requirements are generated by scanning the blueprint describing the end-product and preparing punched cards indicating serial number, effectivity, model, customer configuration, and using assembly.

The second element of input is the introduction of the number of end-products to be produced. This generally comes from a sales order or a forecast of sales. In our system, the work order, as it is called, is introduced in the form of punched cards directly into the computer system. In view of the tremendous capital investment required to support a manufacturing program in the air-frame industry, it is rarely practical to authorize manufacture without specific sales support. This element of input, therefore, is directly identifiable with a specific contract and provides the accumulation point for the detail necessary in cost accountability. The work order is used throughout the entire system as the summary control for all information, with regard to both unit and monetary control.

Example: Work Order 1234 authorizes the manufacture of twelve end-products. Part No. 987654321 is required on two assemblies used in each end-product and costs $25 each. The unit record for the above part number would be as follows:

Part No: *987654321* Work Order: *1234* Unit Cost: *$25.00*

	Required	Ordered	Received	Disbursed
Quantity	24	24	24	24
Dollars	$600	$600	$600	$600

This element of input also provides reference to the increment of manufacture. The lot system, as used at Lockheed, is controlled through the procurement authorization. In order to provide a synchronous flow of material, it is necessary to relate each receipt to the coordinated release within the factory. Here again, the work order is used as the common denominator. Inasmuch as material is manufactured internally in work order groups, it is convenient to schedule the receipt of the material in the same groupings.

The next input element, transactions to date, is that which maintains the current status of each item in the inventory. In includes orders, receipts, and dis-

bursements. This element of input comes about as a by-product of the ledger posting operation and is fed directly into the computer system as described later in this article.

The fourth item of input is the manufacturing planning position. This information describes how, in what sequence, and where the end-product will be built. This is particularly significant as a basic element of input in manufacturing processes having a relatively long span from the beginning stages of production until final delivery. Such manufacturing processes are typical of the airframe business where the span can be as much as a year or more. It follows, therefore, that, if inventory investment is to be adequately controlled, the scheduling of material must involve knowledge of the point in the manufacturing process at which the material will be required. Our experience in reviewing material control systems has indicated that this element of input is perhaps the most frequently overlooked. Lacking this vital element, it is necessary to order all material to the earliest need or defer delivery of certain types of material on the assumption that they are not required at the beginning of the cycle. This is a risky business and frequently results in both an overly inflated inventory and an undue number of shortages.

The manufacturing schedule is the fifth input element. It indicates that point in time at which each item of manufacture will pass through the various stages called for in the manufacturing plan. The manufacturing schedule is the basis for sequencing all work including purchase orders for material and parts bought outside the company. The scheduling technique used is designed to support the manufacturing plan. It is never changed to accommodate production or procurement problems and, therefore, provides an automatic means of establishing priorities.

The last item of input relates to procurement controls and is a multiple element which includes the various policies concerning inventory level, financial limitations, procurement time, vendor history, previous buys, etc.

Action Required — And Output

The action to be performed on the input data has been broken down into five basic steps. These steps are applicable whether they are performed manually, mechanically, or electronically:

1. *Application of procurement authority to requirements* — The first step required in the processing of the input data involves the extension of requirements necessary to support the procurement authority. In short, a basic requirement on a given item of 2 per

end-product, when applied to a procurement authority of 12, establishes an extended requirement of 24. Here again, this extension is by work order so that the requirement may always be related to the sales contract authority.

2. *Summarization of transactions* — The second step necessary in processing the input is that involving the summarization of orders, receipts, and disbursements. Purchase orders are summarized by scheduled date, so as to provide a basis for material position analysis, and receipts are summarized by purchase order. The disbursements are summarized by work order and separately processed according to their relation to requirements. A planned disbursement is so identified at the source and is matched against related requirements. An unplanned disbursement is identified as such and is, in effect, established as a requirement unto itself.

3. *Determining quantity position* — The third processing step is that of calculating the quantity to be ordered or to be declared surplus. This is accomplished by matching requirements, including unplanned disbursements, with the quantity ordered. A plus condition indicates ordering action is required. A minus condition is indicative of surplus.

4. *Application of schedule* — Once the quantity to be ordered has been calculated, it then follows that the schedule of need must be determined. This is accomplished by using the input elements of manufacturing schedule and transactions to date, as previously described, in conjunction with the calculated quantity to be ordered. It is here that the manufacturing plan is used to modify the schedule for the end-product or major assembly to determine the specific need-date of the item in question. The effect of this calculation is the determination of the schedule of quantities yet to be disbursed.

5. *Application of procurement controls* — The above calculated quantity is a raw figure representing the specific quantity required to support the disbursement schedule. This and other like quantities and accompanying schedules must now be modified to comply with policies concerning maintenance of an economical inventory level, limitations of financial liabilities, procurement time, vendor history, price break quantities, packaging units, scrap history, etc.

We now come to the essential reason for having performed all the above operations, that of generating action documents or reports. These are four in number. The first element of output is the distribution of material charges necessary to support the various accounting ledgers and reports. The second and perhaps most important element of output is the generation of the purchase order. Each purchase order is identified to the sales contract representing the

procurement authority for the quantity ordered. The third item of output is the declaration of surplus material which later results in the surplus material being offered for sale, thereby purging the inventory of unusable material. The fourth element of output covers the many reports and material studies required to properly evaluate the status of the inventory.

Objectives — And The Search For Equipment

Prior to 1954, these operations were performed manually, using a typical material control record card. This record was originally designed to accommodate the manufacture of a single end-product sold to a single customer. It was in keeping with the standards that existed at that time and did an adequate job. As the company grew, however, we took on the manufacture of many different models, with customer variations within models. With an increasing number of customers, it was not long before the manual record was rapidly proving inadequate. The basic problem was not one of recording data on the record but, rather, one of extracting data from the record. Various devices were developed to assist in this extraction, such as the use of colored pencils, multiple-block entries, etc. The colored pencil experiment progressed to the point where the standard colors had all been used and it was necessary to secure special pencils with colors such as heliotrope, sea green, etc. There was, of course, no adequate means of extracting data in summary form. The inadequacy of this record to cope with the complex problems involved resulted in management's request to develop a mechanized system of some sort. In developing the new system, we first established the basic objectives to be used as a specification for evaluation:

1. Reduce manpower and indirect costs
2. Improve material supply
3. Reduce investment in inventories
4. Reduce processing spares
5. Provide positive administrative control

The various equipment available for this type of work was reviewed. It was generally agreed that the electronic computer offered the greatest promise of complete mechanization but there did not, at first, seem to be any economical solutions to the problem of random accessibility of data which is necessary to answer the hour-by-hour questions typical of a material control function. The standard bookkeeping machine seemed to offer the simplest solution to the random access problem but offered very limited relief from the data extraction and summarization problem.

In 1954, special negotiations were entered into with a local equipment manufacturer, Systematics, Inc., regarding the building of an intercoupling device which would make possible the simultaneous punching of a card as a by-product of the machine posting operation. Such a device was developed in the form of an electro-mechanical intercoupler, which married an N.C.R. bookkeeping machine to an I.B.M. key punch. With this intercoupler we took our first step toward mechanization and data integration in the area of material control. The coupling of machines has proven to be the mechanism needed to span the gap between manual and electronic bookkeeping.

The New System

The basic cycle of document flow in our new system commences with order, receipt, and disbursing documents at the bookkeeping machine position, as depicted by Exhibit 2, even though the source of such documents may have been the data processing center. The data for the transaction documents are posted to the related ledger.

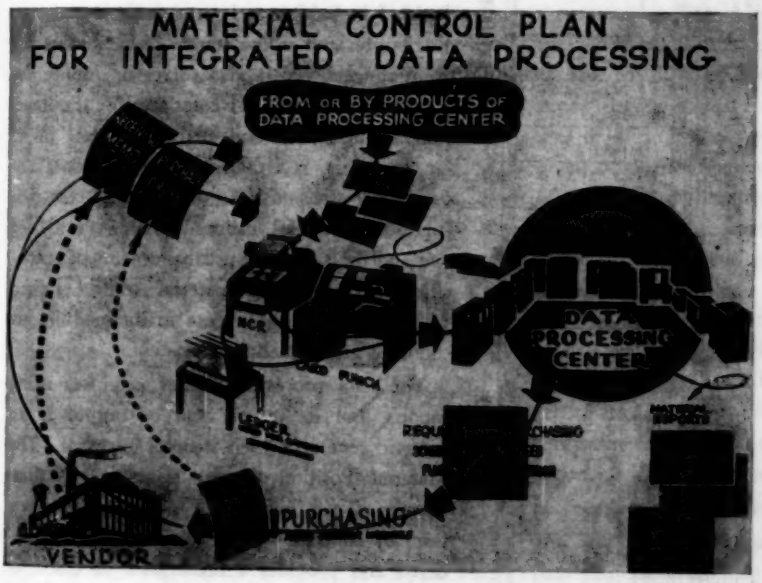
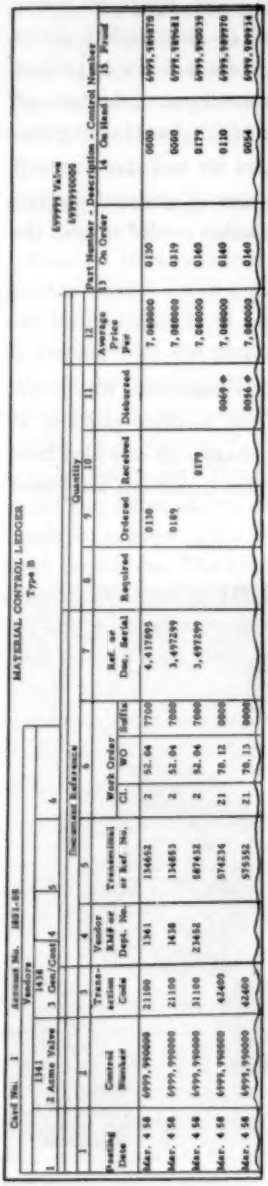


EXHIBIT 2



MATERIAL CONTROL LEDGER
Type B

Card No. 1 Account No. 883-68
Warehouse 1341
1438
2 Ammo Valve 3 Gen/Genl 4 5 6

$99999 Value
$99999000

1	2	3	4	5	Document Reference 6			7	8	9	Quantity 10		11	12	Part Number - Description - Control Number 13	14	15
Planning Data	Control Number	Transaction Code	Vendor Number Dept. No.	Transmittal or Ref. No.	Work Order Cl.	WO	Suffix	Ref. or Doc. Serial	Required	Ordered	Received	Disbursed		Average Price Per	On Order	On Hand	Final
Mar. 4 58	6999,990000	21100	1341	134652	2	52. 04	7700	4.617895		0130				7.080000	0130	0000	6999,585870
Mar. 4 58	6999,990000	21100	1438	134653	2	52. 04	7000	3,497299		0189				7.080000	0319	0060	6999,589481
Mar. 4 58	6999,990000	31100	23452	587432	2	52. 04	7000	3,497299			0179			7.080000	0140	0179	6999,590339
Mar. 4 58	6999,990000	42400		574234	21	70. 12	0000					0069 ⊕		7.080000	0140	0130	6999,589970
Mar. 4 58	6999,990000	42400		575352	21	70. 13	0000					0056 ⊕		7.080000	0140	0054	6999,589914

EXHIBIT 3

The ledger (Exhibit 3) serves two very useful purposes. First, it provides an accessible record for random interrogation to be used for spot updating of the monthly computer produced reports; secondly, it provides an excellent control over the accuracy of input data and generates totals for auditing the output from the computer. Those acquainted with the intricacies of developing a complex computer program will readily recognize the advantage of having a check which can be used to highlight discrepancies in the program. Previous experience in this area has indicated the hazards of producing documents for action without sufficient control of accuracy.

Simultaneously, with the ledger posting process, certain desired information is punched into a card for further processing. The punched card by-product of the posting operation, also depicted in Exhibit 2, is used for material cost distribution and is the source of numerous accounting reports. It also serves as input medium to the I.B.M. 705 computer for the more complex extraction and analysis of data in so far as orders, receipts, and disbursements are concerned. Inasmuch as the material cost distribution card and material analysis card are one and the same, the usual problems of reconciling a quantitative material control record with the monetary ledgers maintained in accounting are virtually nonexistent.

The data processing center produces many reports, but its major item of output is an analytic report of each item of material. The Material Position Record (Exhibit 4) summarizes all requirements of material for a given time by contract. It indicates the quantity ordered and provides a breakdown of disbursements identified as planned or unplanned. It

MATERIAL POSITION RECORD

M.R.C. Date Mar. 18 58 | Part number and Description 699999 Valve | Accts. Date Mar. 58 | Acct. No. 05 | Page 1 | Control Number 699990000

Basic Class	Work Order	Suffix	Quantity Required	Quantity Ordered	DISBURSEMENTS Planned	DISBURSEMENTS Unplanned Change	Rejects	WIP Losses	Scrap	Other	Balances To Be Disbursed	Balances On Order	Balances On Hand	Balances To Be Ordered	Lot or Work Order	E.S. No. I Tag or P.O. Date
1 Tag P.O. or Shop Order																
A			B	C	D	E	F	G	H	I	J	K	L	M	N	O
2	7001	2713								1						
2	7011		35		35		1-								56	
2	7012		69		69		2								57	
2	7013		68		68	1									58	
2	7013	0002							1							
2	7014		68								68				59	
093121																
44	17895	5204		130								130		2	7700	117
Price																
Part Total			708.00 849	705	507	1	1		1	1	342	140		54	147	

EXHIBIT 4

includes a calculation of the quantity to be disbursed, balance on order, balance on hand, and the quantity to be ordered. The lower portion of the report provides a recapitulation of the status of open purchase orders, undispositioned rejection tags, and open show orders (in the event a purchased item is being reworked in the plant). This report provides at a glance the status of each item of material and is used as the main source of determining items in the inventory which require individual attention. It can readily be deduced that a minus figure in the "to be ordered" field is indicative of a potential surplus condition and prompts action on items falling in this category.

Inasmuch as the data carried on the magnetic tapes which produces this report carries the inventory value for each transaction, it is possible to make periodic extractions and summarizations of data indicating monetary balances by contract, in-

cluding dollars on hand, on order, and yet to be ordered. This data is extremely valuable in determining the financial status by contract.

A series of special reports is also produced from this same magnetic tape source which reflects discrepancies between the quantities calculated as required on a given contract with the quantity actually disbursed. Here again, the monetary value is used as a basis for highlighting items that fall above established limits. Such items are investigated and corrective action taken. Items below the limits are balanced automatically by the computer.

Progress to Date

The "art" of material control at Lockheed is gradually changing from one of detail part number control using individual judgment, skill, job knowledge, personal attention, etc., to one of problem area definition on an exception basis. Energy is being expended on those items in inventory which require individual attention and is not wasted on those which are following a normal course.

Based upon our experience to date, it can now be said that major cost savings are possible through electronic data processing. The two areas which appear to offer the greatest return are (1) those involving the automatic generation of action documents, such as shop orders, purchase orders, etc., through computer analysis of elements necessary to such decision making, and (2) those involving the consolidation on magnetic tape of multiple files carrying common information such as material control files, inventory accounting files, purchasing files, etc. Sizable savings can be made here through the elimination of the duplication of clerical effort necessary to maintain separate files. The flexibility of magnetic tape unit record sizes makes such consolidations practical where, heretofore, punched card or manual limitations necessitated their separate maintenance.

The case here given is only one example that electronic data processing is providing a new key to inventory management, a key which gives bright promise of the future. Extensive planning is under way to provide the means whereby the missing elements of input which are still handled manually can be introduced directly into the computer in machine sensible form. Procurement action can then be taken, where necessary, through automatic analysis of all the elements necessary in making such a decision.

The Accountant - Manager — What He Is and Does

by JOHN HIHN, JR.

THE ACCOUNTANT, as a member of the management family, has problems of organization, planning, production and quality control. Above all, he must be able to get things done and to work with people. His function of maintaining accounting and statistical records enables him to bring an objective point of view to the management table. On the one hand, he keeps the records; on the other hand, his analysis of the figures contributes to management. Here are some of the functions of business for which the accountant is responsible:

1. Accounts receivable and payable practices
2. Analysis and development of procedures
3. Analysis and interpretation of business results
4. Budget program—developing and administering
5. Calculating the return on investment
6. Control of plant and equipment costs
7. Control of production costs
8. External and internal audits
9. Financial reports to the board of directors, stockholders, and security exchange
10. Internal reports
11. Long-term financing—data to support
12. Payroll practices
13. Practices of taking and valuing inventories
14. Preservation, retention and distribution of business records
15. Setting standard costs
16. Setting up and maintaining inventory control records
17. Tax control—federal, state and local

His detailed knowledge of the company-wide figures enables him to attain the management's viewpoint, and to answer its questions, which revolve not only around facts concerning where it was but also where it is going. Drawing

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JOHN HIHN, JR., Philadelphia Chapter, 1923, was Comptroller of The Budd Company, Philadelphia, Pennsylvania, when this article was written. Now retired, Mr. Hihn joined this company in 1942 as Plant Controller, advancing to Assistant Controller in 1955, and in 1956 to Controller.

upon his knowledge of the historical facts, the accountant applies these in the light of the future. His ability to give weight to factors in relation to the marketability of the products enables him to forecast sales, provide the related cost at the volume expressed, and the expected profit. Among the questions put to financial men are these:

1. Should a plant or department continue making products for inventory, to meet competition, and price the product accordingly?
2. Where is the break-even point?
3. Should the company expand to meet the demand? If so, what is the payout period?
4. Should the company discontinue a product in a line which is not profitable?
5. How should non-productive labor, services and fixed charges be considered in their respective proportions to the production?
6. What attention must be given to selling and administrative expenses and advertising expense?
7. What policies do growth prospects require?
8. What financial factors influence dividend declarations?

The Accountants' Staff and Standing

The size of the accountants organization varies with the size of the company and the demands which the management makes upon the group. The accounting manager is usually a staff member and a department head, having complete authority over methods and procedures, employment, promotions and dismissals. In administering his department, he must operate within the company's policies, the same as any other department head. The members of his organization are producers of quality, regardless of the time allowed. However, the pressure for facts prevents the accountant's work from becoming mere routine—the unexpected always happens. An important decision is usually due within a short period of time. The department must be organized to produce factual reports on time. Therefore, the people must be organized in their thinking, the work must be scheduled, authority and responsibility must be delegated to the people. Most important is the follow-through and check of results.

The morale within the accountants organization is equally important. Therefore, the accountant must practice the difficult art of human relations; he must take part in solving the difficult problems which can be met only through training, discipline, and firm but understanding approach. The members of his organization must be geared for action, have the desire for security, have recogni-

tion, and have the satisfaction that they have participated in the overall objective. The accountant cannot afford to be aloof. He must get things done through people and, therefore, must act and live like a human being. And, because his department is a service department, he must be prepared to meet resentment. He is very often required to point out unfavorable performance.

We must depend upon the receptive attitude of people—not only those coming under the direct supervision of the accountant but also those reporting to the supervisors of the departments which he serves. Timing is very important here. One of our major problems is to create an atmosphere of receptivity to a procedure, to make the persons concerned look upon it with an open mind. In my opinion, the attitude of top management with respect to formal procedures is most important. When you have a top management that is constantly thinking of new and better ways of doing things, you have the opportunity to release unused talents for work of a more difficult nature. While it is true that our civilization has made greater strides in the scientific and mechanical fields, nevertheless, we have made considerable progress in our knowledge of human beings and their behavior. Having the ability to deal effectively with people is most important to the accountant manager. In fact, it is important to every manager to possess the knowledge of human relations, if he is to be successful.

The growing recognition of managerial potential in accounting is driven home when it is considered that many large companies have reorganized their accounting functions to vitalize their record resources for the executives' use. A section of the United States Steel Corporation's by-laws deals with this:

> "The Controller shall analyze and check, and assist officers of the Company in analyzing and checking, the policies and activities of the Company, as revealed by the records. He shall also assist other officers in determining future policies and plans by developing and interpreting facts and applying good business judgment to the conclusions to be deduced from such facts."

I doubt if it would be possible to establish a scholastic course in management accounting for business, for the reason that it is practically impossible to predetermine answers to the wide range of questions that arise in business today. Further, the schools, colleges and public have glamorized the certified public accountant to the extent that the student does not realize that he has a choice between public and industrial work when he studies accounting. It appears that most of the accounting students have one objective in mind and that is to obtain a certificate. It is believed that any other form of accounting simply

involves keeping records which a certified public accountant checks. This condition has caused many large corporations to establish a cadet training program. These courses are given on the company's time and, in most cases, the individual is paid during the term of instruction. The course embraces the operation of all departments, including manufacturing techniques. Among the companies that have come to my knowledge, that have established a cadet training program are: Armstrong Cork, The Budd Company, Campbell's Soup, General Electric, R. C. A., U. S. Steel, Vicks Chemical, and Westinghouse. These courses may have some effect in righting the balance between industrial and public accounting.

The Accountant's (And the Company's) Best Bet — The Budget

The accountant, as the quarterback on the team has a responsibilty that no machine, to my knowledge, can take. This is especially apparent in budgeting. The economic forecast for the industry is generally considered to be the basis upon which you develop a budget. From this study and factual information with respect to the elements affecting the business under consideration stems the potential for the period in question. The volume of business developed as available, through this study, can be, and in many cases is, ascertained through the use of data processing equipment. But first you must program the relationship of facts and formula—in other words, instruct the machine what to do and where and when to do it, each step along the way. If the development of the factors is realistic and the machine is correctly instructed, it will develop a result that may be accepted as the goal. The application of this basis is where the human element comes into being.

It involves many questions. Is the volume beyond the capability of the mechanical and financial structure of the enterprise? Does the market present an even flow or is it seasonal? If seasonal, is the product one which may be partly manufactured ahead of final assembly? Will it be necessary to store semi-finished or finished products near the distribution center, so as to assure timely deliveries? How much capital will it take to finance the necessary operations? Is the cash available or will it be necessary to contract for a loan? If so, what kind of loan? What interest rate can the company afford to pay without adversely affecting the selling price or the profits? What will the merchandising program be? What medium of advertising will be used?

The accountant has, when answers (which he can encourage) have been made to these and some subsequent questions, much of the factual data to set the standards for production and to estimate the profit. In doing so, he is entering

a broad field of usefulness. Profit planning and profit control are two techniques which the accountant must develop to be successful. Profit planning means budgeting all expense in relationship to volume of production. Profit control means administration of the budget in such a manner as to realize the profits established in the budget. The word, "budget", seems to scare the average person when that term is applied to a job to be done. Actually, however, the term has become a part of everyday life for most of us.

What is a budget? A budget is a listing of expenses to be incurred during a given period of time. This list must be tailored to reflect the amount we can afford to spend in order to accomplish a specific goal. To assure that the company will remain healthy, the jobs of the employees will be secure, and the company will be contributing to the general economy of the country, our goal would embrace the following:

1. To produce the best possible product at the lowest possible price.
2. To earn a fair return on the investment the stockholders have made in the business.

For what do we use the budget? Budgets are used as an aid or a guide in controlling our costs by providing:

1. A planned goal or objective for a specified time—usually a year.
2. A yardstick for measuring the day-to-day performance against the goal.
3. A basis for application of sound pricing principles.
4. A basis for long-range plans for expansion, modernization and new business.
5. Elimination of unprofitable lines.

How is the budget prepared? Basically, in developing a budget there are only two main ingredients. First, a record of past experience of expenditures is prepared, together with an analysis of how much these expenditures were in excess of what we could afford to spend. Second, realistic consideration is given to past experience in determining current budget expenditures, in order that the budget will contain a task to accomplish economies and be in line with the company's goals.

Who prepares the budget? There is a very simple answer to this question. Those who represent management at all levels of supervision are the people who determine the necessary expenditures, in line with company goals. The accountant is charged with the responsibility of assisting them in this direction and preparing the final form for top management. The accountant's vast

knowledge of the company's performance in all of its phases make him best qualified to do this job. All costs are measured against the budget allowances, and therein lies the tool for control. The use of accounting information by supervisors and foremen who stand at the final level of delegation of management authority and whose authority is to direct the work of direct and indirect labor, is the concern of the accountant.

The number of indirect labor people in each classification is established to service the plant operations at the going level of production. As the demands for such services vary, the number of people in the service department vary. The extent of this variation is expressed in the budget from the very beginning. In other words, the effect that variables will have upon the service departments is known by the department head before they happen, which allows him to plan his work.

A factory supervisor, under certain circumstances, has little planning. This is especially true in a mass production industry, in which large quantities of identical products are manufactured in accordance with customers' releases which are subject to change on short notice. Nevertheless, the foreman's responsibilities are not light. He is primarily responsible for seeing that the required quantities of high quality products are produced in accordance with the planning division's predetermined schedule, through the most effective utilization of the men, machines and materials within his department. This also means that he must make sure that he receives fullest cooperation from service and maintenance departments, to assure uninterrupted production without unduly increasing the overhead cost of operating the department.

Cost Analysis and Cost Reduction

Cost analysts who represent the accounting function are on the production floor to serve the factory supervisor in his effort to discharge his functions. The cost analyst is a qualified industrial accountant having full knowledge of the manufacturing procedure and the standards applicable to it. He is charged with the responsibility of reporting variations from standard. These variations are usually coded, so as to expedite the flow of information. All such excess costs are related to the quantity produced. The cost of spoilage is also calculated, based on the quantities scrapped.

Besides making good use of his labor force, the factory supervisor must maintain a continuous flow of work through the machine lines in his department, in order to meet his standard production. Machine failures and other interruptions that occur intermittently for a variety of reasons are costly. Daily efficiency

reports embracing all costs are issued to the various levels of management. Such reports must be timely and accurately compiled, if they are to be meaningful. Prompt disclosure of causes of variances enables the supervisor to take corrective action.

Then there is cost reduction, a management area of much importance, in which the accountant can participate very actively. Cost reduction programs fall into three general categories:

1. Elimination of costs arising from inefficient operations and unnecessary activities.
2. Elimination of certain activities that are nice to have but are not absolutely necessary.
3. Reduction of operations or activities without sacrificing quality, usually a temporary measure.

A few general principles might be kept in mind in developing a program of cost reduction. Cost reduction must have strong support of top management and this must be reflected through department heads and supervisors, and on down to everyone in the organization. Supervisors responsible for the incurrence of costs are the ones in the best position to control and reduce them. Other people in the organization may be of assistance in the program, but savings can best be made where costs are incurred. The influence that supervisors at the lower levels have over costs is amazingly significant.

A separate organization (such as department) should not be established for carrying out the cost reduction program. A committee to plan and coordinate the program may be necessary but the results must be accomplished through the existing administrative organization if it is to be effective and have any lasting advantage. Costs must be known before they can be controlled and reduced. Such costs must be segregated as to responsibility and the cause identified before corrective action may be taken. Savings can be achieved through creative thinking and imagination as to new designs, new manufacturing processes, new selling ideas and new accounting methods.

Managing is a Thinking Process

To summarize the functions of the accountant-manager are to:

1. Conserve and guard the property and business of the company.
2. Control the procedures for proper recording of all financial transactions.
3. Control the assembly of accounting detail into meaningful state-

ments and reports for supervision, management, stockholders, and governmental agencies.

4. Recognize, evaluate and make policy as to problems which arise because of industry or government conditions.
5. Interpret that which has occurred and forecast that which may reasonably be expected.
6. Plan the flow of information to and from the record-keeping section of his department.
7. Maintain an organization capable of resolving problems at various levels, as they arise.

These functions seem to require a type of sound judgment which I do not believe any machine can exercise. The accountant is very grateful to the people who have developed and produced mechanical equipment to lighten the detail load. However, he hardly needs to be reminded that it takes brains and initiative to do an accountant's job—which the machine does not have.

Those Diminished Dollars in Fixed Asset Costs

by W. A. SILLS*

ALL OF US, I suppose, are open to persuasion by a rather narrow margin. We have long since sorted out our ideas, accepted some, rejected others, and formed convictions which we are prepared to defend. Our very sanity, our escape from original chaos, is dependent on our doing this very thing. We like to read books and listen to lectures that confirm our convictions, but let any one attack those convictions and we steel ourselves against that person. We close our minds to him. We avoid him. The more convincing his argument, the more true this is, because listening would drive us back into the chaos from which we have escaped.

This, I feel, in a measure describes the situation in which accountants find themselves with reference to the question of depreciation on replacement

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values. Suggestion to adopt the idea, accountants feel, drives them toward that chaos from which they have escaped by means of present methods. It might open the way for arbitrary manipulation—for depreciation when convenient. It would not conform to recognized accounting procedures. It could not be consistently followed. It would not be based on objective evidence. Account for replacement? Why, that means bringing into the books a record of events that are in the future, events that may be affected by future technological improvements, by future changes in the purchasing power of the dollar!

But is there no treatment of this problem which is both objective and reasonable and which might be followed consistently? Isn't determination of income through accounting of necessity a compromise between theory and practical consideration? Isn't compromise involved in the charging for past service credits under a new pension plan, in the various methods of valuing inventories, in the refusal to recognize profit until it is realized, and in other more special situations like the accruing of interest on bonds owned but not the accruing of dividends on preferred stock owned until such dividends are declared? Isn't it involved, too, in various methods of writing off cost of patents and other intangibles? Aren't these all compromises that are considered practical?

Why, then, can't we approach this problem of depreciation on replacement value in a similar fashion? Do not think of this approach as accounting for replacement but as accounting for loss of capital resulting from the deterioration in the value of the dollar. That is the heart of the problem and it is just as important to account for this type of exhaustion of capital as for that resulting from physical causes.

Suppose we were to keep our records of fixed assets on the basis of cost, just as we do now, and figure depreciation on cost, also just as we do now, but in addition, classify assets and depreciation by year of acquisition. This classification by years would need to go back only to 1939 because, prior to that year, the value of the dollar was fairly stable for a time. To proceed from this point, however, we would need the cooperation of the government. We would request the Federal authorities to issue a new index series which would indicate what has happened to the purchasing power of the dollar since 1939. Let the index be issued quarterly so that companies on a fiscal year basis might use the figure for the quarter nearest the end of their year. The index now available and which most resembles such a guide is the Consumer's Price Index. This figure could be used if the Government would issue no other.

The depreciation-on-cost basis would be applied as a charge against income

and a credit to a reserve for depreciation, as at present. In addition, there would be a further computation. The amount of depreciation on cost would be multiplied by a fraction, the numerator of which would be the index for the current year and the denominator of which would be the index for the year of acquisition. The depreciation on cost would be deducted from this product and the resulting figure would represent additional depreciation to be deducted from income, with a corresponding credit to a reserve called "reserve for exhaustion of capital caused by the deterioration in the value of the dollar".

If, at any time, this fraction were less than unity, that is, the index for the current year were less than the index for the year of acquisition, then the amount computed would be deducted from the depreciation on cost and the entry made in reverse fashion. This process of reducing depreciation on cost and charging the reserve would continue as long as there remained any credit in the reserve account. In the event that the reserve were ever exhausted, depreciation on cost would be taken as heretofore. There are, of course, many details of such plan which would have to be worked out. However, they are such details for which solution could be found.

We should press for the allowance of this additional depreciation by the Internal Revenue Service as a deduction in figuring taxable income. If we are convinced that it is right and important that we record the loss of capital caused by the declining value of the dollar in our income statements, why shouldn't we insist on such an allowance? If you think this a wild idea, may I remind you that the Service has recognized "lifo" as a method of valuing inventories in computing taxable income. There is a marked inconsistency in valuing inventories by "lifo" and figuring depreciation on cost.

What we would accomplish by this procedure would be the expression of depreciation in dollars of the same vintage or purchasing power on the cost side of our income statements as the dollars for gross income on the revenue side. The sales dollar is a dollar of current value. We should not deduct from it a dollar which we spent ten years ago and which, therefore, is valued at the purchasing power of ten years ago. We cannot do this and expect to get a result that is significant.

Using Statistics To Measure the Accuracy of Forecasts

by R. CLAY SPROWLS

"WHEN COSTS ARE PROJECTED into the future as a component process, in the total process of planning, the projection usually reflects the acceptance of stated relationships between one cost and another or between the cost and some other type of base. The degree of accuracy of these relationships then underlies the usefulness of the forecast."[1]

These two sentences from the summary preceding the main body of the article referred to, summarize very well two main problems in using statistical relationships to forecast anything: (1) the specification of a relevant mathematical relationship between variables and (2) the accuracy with which this relationship is estimated from sample data.

Gaylor illustrates one standard statistical method for testing the hypothesis that there is, in fact, a relationship between the two variables under consideration in the simple case of a linear relationship. In particular, he employs the sample correlation coefficient for this test. Using data on direct labor expense, material purchases, and materials handling expense, he calculates a correlation coefficient of 0.98 between direct labor and material handling expense and 0.85 between material purchases and material handling expense. He then asks the correct statistical question about both of these correlation coefficients: Could a value of 0.98 (or 0.85) be secured purely by chance from a population of relationships in which there is actually no correlation between direct labor expense (or material purchases) and materials handling expense? He tests the null hypothesis that there is no correlation between the two variables and, in both cases, rejects this hypothesis in favor of the alternative that a linear relationship does exist between direct labor (or material purchases) and materials handling expense. He then decides to use direct labor expense as a predictor for materials

[1] "Statistical Testing of Relationships Used in Cost Planning and Allocation," Edwin W. Gaynor, *N. A. C. A. Bulletin*, May, 1957, p. 1114.

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handling expense because it has the higher correlation coefficient (0.98 vs 0.85).

Well, so far, so good. Statisticians always welcome discussions and applications of their methods, and recent years have seen accountants expressing a strong interest in statistical methods. In fact, whole books have been written presenting standard statistical theory and methods as they relate to accounting problems.[2] While they welcome this increasing interest in their field, statisticians also like to see their methods used and explained correctly, as does a specialist in any field (including, one suspects, accounting). Gaynor has used statistics correctly as far as he has gone in his application of testing of relationships in cost planning. One implication of his article should, however, be pointed out to accountants who may themselves be interested in using the method suggested. This is the implication that a high degree of correlation (a high correlation coefficient) is synonymous with a high degree of accuracy in the forecasts made from the statistical relationship. Such is not always the case, especially when the correlation is measured from a small sample.

The main burden of this paper is to show how one may extend the method started in Gaynor's article to an exact measurement of the margin of error in the estimates made from the linear relationship between direct labor expense and materials handling expense, using the same data as an example. Nowhere is there an intent to criticise what Gaynor has done. The intent is rather to suggest an extension of his work to make it even more meaningful and useful to accountants who are charged with the responsibility for cost planning and who are ever watchful for new and more reliable quantitative methods to use.

A Review of the Example

The original data on direct labor and material handling expense are reproduced in Exhibit 1. Direct labor is given in millions of dollars and material handling expense in hundreds of thousands of dollars. It is from these data that Gaynor calculates a correlation coefficient of 0.98. The basic calculations supporting this figure are given in his article and need not be repeated here.

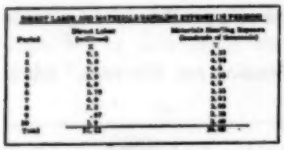


EXHIBIT 1

[2] See, for example, *Statistical Sampling for Auditors and Accountants*, Lawrence L. Vance and John Neter, John Wiley, 1956.

Some additional calculations lead to a linear estimating equation

$$Y_e = 2.053 + .318\,X$$

where Y_e is the estimated or forecast material handling expense (in millions of dollars) and X is direct labor cost (in hundreds of thousands of dollars).[3]

An example of the use of this equation is given for a direct labor expense of $5,142,000 ($X = 5.142$) which happens also to be the average direct labor expense in the sample data. Substituting in the equation above,

$$Y_e = 2.053 + (.318)\ (5.142)$$
$$Y_e = 3.688 \text{ or } \$368{,}800.$$

This means that one would forecast a material handling expense of approximately $369,000 when the direct labor expense is just over $5,000,000. Similarly, if direct labor expense is $15,000,000 ($X = 15.0$), the estimating equation gives a material handling expense of $682,000 ($Y_e = 6.823$).

Material handling expense forecasts are given in Exhibit 2 for seven selected direct labor costs, including the largest, smallest and average direct labor costs of the sample. These forecasts are only estimates of the material handling expense one would expect "on the average" for various levels of direct labor cost. The implication is that they are sufficiently accurate estimates to be useful in cost planning forecasting because the correlation coefficient of the sample data on which they are based is very high (0.98). The useful accuracy of the forecasts given in Exhibit 2 should not be taken for granted. Not only may high correlations be misleading, but one need not assume a useful accuracy because it can be measured from the very same data that yield the correlation coefficient.

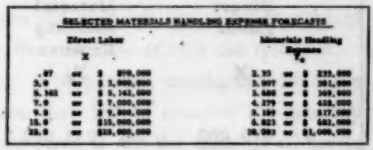


EXHIBIT 2

Two Forecasting Problems and the Question of Accuracy

There are really two forecasting problems, both of which can be illustrated with these cost estimates. One is the average material handling expense for a number of time periods, each with the same labor cost. For example, if the time period is one month, one may know that labor costs will remain about

[3] Throughout this paper, detailed supporting equations and calculations will not be given because they are ever so much more complicated than Gaynor's. A specific reference which spells out these calculations in detail is *Elementary Statistics*, R. Clay Sprowls, McGraw-Hill, 1955. See Chapter 10 as a whole and especially pages 234 to 239 and 243 to 250.

constant for a period of six months. The forecast is, then, the average material handling expense for these months, each with this same labor cost.

The other forecast is a material handling expense for a given time period, say, July of 1959. This is not only a different problem technically, but it implies a different and lesser accuracy than a forecast of the average. Averages may be estimated more reliably than individual items. At the same time, it appears that the latter forecast is the more meaningful for cost planning of the type posed in Gaynor's article. Forecasts of averages are more useful, for example, on job costs where one may actually have a large number of jobs of approximately the same size for which he wishes to predict the average cost, rather than the specific cost of an individual job.

ACCURACY OF MATERIAL HANDLING EXPENSE FORECASTS

(95% Confidence Intervals)

Direct Labor X	Material Handling Expense Y_c	Accuracy of Mean Forecast	Accuracy of Individual Forecast
$ 870,000	$ 233,000	±$ 29,400	±$ 60,000
$ 3,000,000	$ 300,700	±$ 17,200	±$ 55,700
$ 5,142,000	$ 368,800	±$ 16,700	±$ 55,600
$ 7,000,000	$ 427,900	±$ 17,100	±$ 55,700
$ 9,800,000	$ 516,900	±$ 30,900	±$ 61,400
$15,000,000	$ 682,300	±$ 59,100	±$ 79,500
$25,000,000	$1,000,000	±$112,400	±$124,000

EXHIBIT 3

A summary of the accuracy of the forecasts given in Exhibit 2 is shown in Exhibit 3. The measurements are in terms of plus or minus dollars for each of the seven levels of direct labor cost. One set of figures is the margin of error of the forecast average; the other is for the forecast individual material handling expense. These may be interpreted as follows:

> *Average:* If a number of time periods each have a direct labor cost of $3,000,000 ($X = 3.0$), the estimated average material handling expense per period is approximately $301,000 plus or minus $17,000, or from $284,000 to $318,000. Since the estimate and its reliability are based upon a sample, this interval prediction is subject to error. It may, in fact, not include the true, but unknown, expense. However, the interval or margin of error is so computed that the odds are 19 to 1 in favor of its being correct and only 1 in 20 of its being wrong. Stated another way, one can be 95 per cent confident that the interval

will predict the expense item correctly. If a higher degree of confidence is needed, it may be obtained only by increasing the width of the interval when the sample size remains fixed.

Individual: If a specific time period has a direct labor cost of $3,000,000 ($X = 3.0$), the forecast material handling expense is $301,000 plus or minus $56,000 or from $245,000 to $357,000. Again, the degree of confidence in the correctness of the estimate is 95 per cent and can be increased at the expense of a wider interval.

Each of the forecasts given in Exhibit 3 may be interpreted in one of the two ways illustrated above. It appears that the most useful forecast for cost planning is a prediction for a given and specific period of time. This is also the least accurate forecast. The real and important question becomes, then, one of very practical significance: Is a forecast of material handling expense of between $245,000 and $357,000, or to within plus or minus $56,000, useful? This question can be answered only by the specialist in cost planning forecasting who must use these data. A statistician can only tell him what is implied by the data; he cannot make the decision that the data answer the question.

Exhibit 3 also illustrates a point which is very often overlooked by those dealing with statistical relationships because they fail to measure the accuracy of their predictions. The dollars and cents error is not the same at all levels of direct labor cost. In fact, it is smallest at the average direct labor cost ($X = 5.142$) and will never be smaller than this for a given sample size and degree of confidence. Moreover, the farther direct labor costs depart from this mean, either above or below, the wider the margin of error and the less useful the predictions become. At the lower limit of the sample data given in Exhibit 1 ($X = 0.87$), the individual forecast is accurate to within plus or minus $60,000. At the upper limit of the sample data ($X = 15.0$), the individual forecast is accurate to within plus or minus $79,500. Very serious errors can be made by assuming greater accuracies than exist for forecasts from values of the predicting variable outside the range of the sample data. For example, if direct labor cost is $25,000,000 ($X = 25.0$), the estimated material handling expense is accurate to within plus or minus $112,000 for estimating the average and plus or minus $124,000 for estimating the individual period expense. These are very much larger margins of error than occur within the range of the sample data.

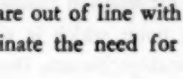
In addition to giving the forecaster some information about the accuracy and, therefore, the usefulness of his forecasts, the margins of error, as illustrated in Exhibit 3, give bounds on the differences between forecast and realized costs which can be reasonably tolerated. If, for example, the actual material

handling expense turned out in one period to be $330,000 for a direct labor cost of $3,000,000, one should not be disturbed. It is true that the expense is $30,000 or 10 per cent above the forecast figure of $301,000, but it is well within the limits of variation that have been observed in the past and upon which the forecast is based. The statistical margins of error are a guide to a search for a serious "cause" of a cost that appears to be too high.

Need to Use All Relevant Techniques

The emphasis here has been upon a cost that is too high. From the statistical point of view, a cost that is too low should also be investigated. Management may not be affected by a low cost in the same way that a high cost affects it. Nevertheless, if the "cause" of the low cost can be found, it may give a clue to a change in policy or procedure which will lower all costs in the future.

The whole point is that, unless one measures the margin of error, he can only assume that his forecasts are accurate enough to be useful and he can no more than guess when actual costs are out of line with his forecasts. Statistical methods are available which eliminate the need for both the assumption and the guess.



Getting and Using Cost Reduction Suggestions — A Team Approach

by L. TELLANDER

THE TERM "product cost reduction" is certainly not new to industrial people. It is doubtful, however, if it has been discussed as much in the past decade as in the last year. There is no doubt that all industries have felt the effects of the (now receding) recession, particularly in the appliance field. The days when the sales department could say, "You build 'em and we'll sell 'em," are gone. Today's "Mrs. Housewife" wants more features, better quality, greater value and—at less cost. With ever-improving automated equipment, it is more true than ever that increased production could mean decreased unit cost. However, in the present competitive market, it is not so easy to put on a couple of salesmen, or a new selling force or a new selling campaign, and end up by increasing factory volume. This, obviously, has caused management to look in other areas for profit. One of the most lucrative areas for increasing profit is cost reduction.

This writing deals with profits—and some of the various methods that the St. Joseph Division of Whirlpool Corporation has used to get improvements. It should be understood that Whirlpool uses many techniques (tools) to save money. However, the topic here is specifically product cost reduction. This means reduction of the cost of labor, materials and component parts through engineering refinements, manufacturing improvements, and economies in purchasing. Whirlpool's program started in 1950. It originated by establishing cost reduction committees for each of our products. Their purpose, in general, was to discuss costly areas of processing that they felt could be improved. They would generate cost saving ideas in this manner and present them to the departments concerned for their action. This was quite an effective program, but it restricted the idea-making to a small group.

As production and the complexity of the manufacturing operation increased, it was apparent that this system was not either particularly efficient or the most effective. As a result, the cost reduction committees, or, as we call it now, the

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LINN TELLANDER has been working for the Whirlpool Corporation for the past 5½ years. He now holds the position of Manager—Cost Reduction Department. Mr. Tellander's past experience and training with Whirlpool took him into the quality control, manufacturing, industrial engineering, tooling, and methods departments prior to his present assignment of co-ordinating cost reduction programs for the St. Joseph Division.

team, changed its direction. Its new function is to create cost reduction "stimulation programs" and to process the ideas of others that result from the programs. The new approach has a "pyramiding" effect. Not only does it arouse many more ideas, but it has, in turn, caused the entire division to be considerably more cost conscious about everything. It is an impossible task to cause 1700 people to become cost conscious overnight, but the various programs that were organized were met with enthusiastic participation by both hourly and management employees. The system to be described is not a monetary suggestion system. The payment for suggestions and ideas created in the cost reduction programs is in the form of personal recognition and/or departmental recognition. The procurement of suggestions is the more glamorous part of a cost reduction system. The more difficult part is to process the suggestions and actually get them into production. It is accomplished with a plan and an organization that can put practically any good cost savings idea into action.

Cost Reduction Team Organization and Responsibilities

At the St. Joseph Division of Whirlpool Corporation, we are now building two separate products: an automatic washer and a combination washer-dryer. To more effectively control the costs of these two products, we have organized a separate cost reduction team for each. These two teams are nearly identical in respect of the manpower and the job origin of the team members. To be more specific, there is a man on each team from the purchasing department, the tooling department, the engineering department, the cost department, the planning deparment and the industrial engineering department. The activities of these people only partly consist of their participation on the cost reduction team. In addition, there is a full time cost reduction engineer who reports to the director of the manufacturing engineering department. The engineer is the chairman of both cost reduction teams. These teams have been picked and selected so that, through their combined efforts, nearly all cost reduction ideas or suggestions can be processed. In the event of a suggestion or a proposal that requires some specialized effort, we involve the persons or departments where the most precise reliable information can be obtained.

The purpose of the cost reduction team is not to conceive ideas. Its function and purpose is to motivate the division employees and make them cost conscious and, further, to provide them the opportunity to make cost reduction suggestions. Each team member is responsible to assist and/or supply information to any employee to aid in the creation of cost reduction ideas. A cost reduction report or log is the guide of all the team members. They are assigned

as coordinators for certain items of cost reduction to which their respective departments are most closely related. For example:

1. A part which is now made of zinc die cast could be made of bakelite. A change of this type requires an engineering department decision. However, it is a purchased part, so the team member from the purchasing department would be assigned as coordinator.
2. Perhaps a stamping is thought to be of a heavier gauge than necessary. This too is an engineering decision. However, the department most affected is the tooling department and the team member from that department would be assigned as coordinator.
3. A change could be suggested to revise an assembly fixture for a multiple or semi-automatic operation. The decision for a change of this type rests in the tooling department. The coordinator assigned would be from the industrial engineering department.

The foregoing arrangements involve at least a double check on the departments most intimately concerned. The intent, however, is to facilitate the teamwork approach by directly involving the departments most affected.

The Cost Reduction Log; Setting Goals

We feel that one of the best tools to assist follow-up of ideas is simply to inform everyone in the division who is wholly or partly responsible for the function of his department of the potential cost reduction that can be affected in his area. We found that reports or lists of items of cost reduction published monthly were not sufficient. A fast-moving program would obsolete many of the ideas or put several ideas into production before the report could be fully circulated. Analysis indicated that some departments were concerned only with particular items. Other departments were concerned only with part numbers. A few departments kept track of ideas by production dates and some departments were just concerned with the numerical item number.

To satisfy all these needs, we constructed a report (Exhibit 1) which is in a small booklet form. There is one cost reduction suggestion or item on each page. The page is half-size 8½" x 11" paper. We use a "preprinted" stencil sheet so that all basic information required is on the sheet. This report is maintained continuously. Any changes that occur in the suggestions, in the decision date, or in any of the people involved is recorded immediately. A new page is issued and the recipients make the change automatically. To avoid confusion, there is a separate report for the automatic washer and for the combination washer-dryer.

Item 138

AUTOMATIC WASHER COST REDUCTION

P - 5703-38

81307 Hose Bag.

Eliminate this part by coiling the inlet hoses and dropping them over the agitator for shipping.

GENERAL INFORMATION

Assigned to Project for Final Decision:	J. Mueller
Coordinator:	C. Averill
Unit Savings:	$ .013 Est. $ Act.
Tooling Cost:	$ none Est. $ Act.
Originator (s):	W. Fester & R. Yeske

STATUS

Completion Date		By
Design:		
Costing:	6-25-58	L.T.
Make or Buy:	Not required	
Testing:	8-10-58	J.M.
Decision:	8-15-58	J.M.
Production:		

Remarks: This must be checked by Shipping to see if the hose would jump off the agitator during "humping".

Parts Affected: Eliminate 81307.

Models Affected: Common Automatic, St. Joseph and Clyde. 10-16

EXHIBIT 1

As soon as an item is approved, a new sheet is released. It is similar in design but on different color paper. This is usually the first notice of approval of the impending change. All efforts are then directed towards putting the change into production as soon as possible. A firm production date is established by the planning department team member and the objective of the entire division is to beat that date. Periodic notices are sent to all recipients of the reports, informing them of groups of items that have gone into production. These notices are issued on a monthly basis. The items that have gone into production will be removed from the report and can be filed or discarded. This system provides an excellent record of activity for any given period.

It is our opinion that any good cost reduction system must have a goal. These goals must be high but not unattainable. The dollar amount of the goal can be recorded a number of ways. We have chosen an annual amount for the division and a total unit savings for each of our two products. For the purpose of determining our goal, we separate the division into three categories:

1. *Engineering* goals are usually the largest in dollar value. The department sets its own goals, the basis of which are design changes for material and labor savings that result in cost reduction.
2. *Purchasing* staff predict their goals based on skillful buying, price negotiation and quantity buying.
3. *Manufacturing* bases its goal on methods improvement, automa-

tion, improved plant layout and economies that can be achieved through improved scheduling.

A report is submitted each month to the division staff. Its purpose is to portray the progress of each of these groups relative to meeting their respective goals at the year's end. The combination and automatic washer progress is reported separately on a chart, as illustrated in Exhibit 2.

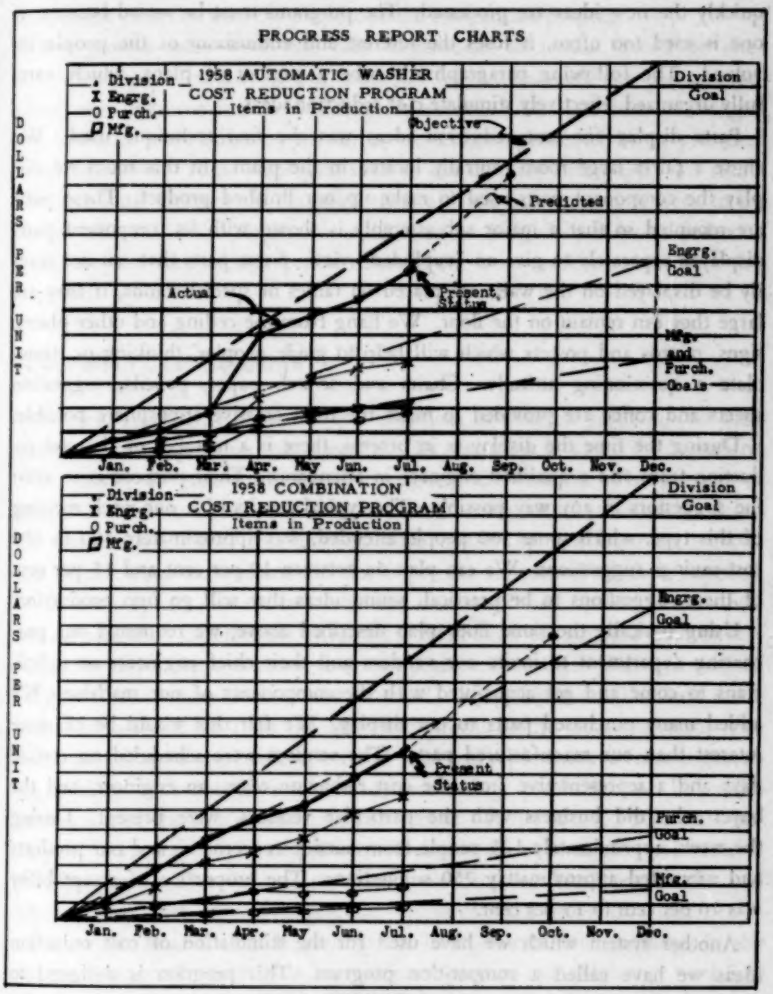


EXHIBIT 2

There are, practically speaking, an unlimited number of ways to stimulate employees (and others) into cost-consciousness. Any program that will organize group or individual thinking into the channels of cost reduction will be useful. We find that the drawing power of these programs depends on how quickly the new ideas are processed. The programs must be varied because, if one is used too often, it loses the interest and enthusiasm of the people involved. The following paragraphs describe a number of plans, which, carefully organized, effectively stimulate cost reduction ideas.

Parts display for cost reduction ideas was the first technique used. We chose a fairly large room centrally located in the plant. In this room we display the component parts used to make up our finished product. These parts are mounted so that a major sub-assembly is shown with its component parts displayed separately to give an "exploded" view. Some parts that can not readily be displayed on the walls are placed on tables or special stands, if they are large they can remain on the floor. We hang from the ceiling and other places, signs, mottos and posters which will help to guide peoples' thinking or stimulate a questioning attitude. Chairs and scratch paper, pencils, suggestion sheets and coffee are provided to make the most creative atmosphere possible.

During the time the display is in process, there is a member of the cost reduction team and a qualified engineer in attendance. Their purpose is to assist the suggestors in any way possible. The typical results of a one-week meeting of this type, which some 300 people attended, was approximately 500 to 600 cost savings suggestions. We can plan on between 10 per cent and 15 per cent of these suggestions to be practical, sound ideas that will go into production.

Using basically the same floor plan described above, we requested our purchasing department to invite our vendors and their chief engineers or technicians to come and get acquainted with the components of our machine. We added many purchased parts to our display. We felt this would be of more interest than our manufactured parts. The vendors were scheduled on certain days and a representative from the cost reduction team, an engineer, and the buyer who did business with the particular vendors, were present. During the week, approximately 125 people from outside concerns viewed our products and submitted approximately 250 suggestions. The proportion of acceptability was 10 per cent to 15 per cent.

Another system which we have used for the stimulation of cost reduction ideas we have called a competition program. This program is designed to make use of the inherent competitive attitudes that make up all effective

businesses. To organize the competition program, we split the division into 10 different teams. These teams included the combination engineering department, automatic engineering, test laboratories, tools and operations, purchasing, the cost department, assembly lines, sub-assembly and fabrication, inspection and the personnel department. Publicity via letters to management people, our daily newspaper and our monthly publication *The Wash Line* was used to acquaint everyone with the purpose of the competition program.

The ground rules were that each department or section would be rated each week by the number of cost reduction suggestions made per person. Trophies were invented for the winning departments and, as a form of recognition, pictures were taken of the entire department personnel being presented with the trophy. These were published in our monthly newspaper. To stimulate individual creativity, a personalized award was presented each week to the person who made the suggestion which was, as judged by the cost reduction team, the best idea of that period. Results for a six week program were 450 acceptable ideas.

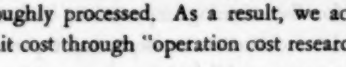
"Operation Cost Research"

A recent and highly successful cost reduction stimulation program, just completed, we call "operation cost research." In general, it involved the organizing of a number of brain-storm teams throughout the division. The purpose of these teams was to create cost reduction ideas for the combination washer-dryer. We named these teams "cost research teams" mainly because the usual connotation of the word brain-storm did not imply the seriousness of their function. To be more specific, a cost research team was established by each of our production and staff departments. The department head appointed a man to represent his department as team chairman and each of these chairmen formed a team of six or more men to "cost research" the combination. The team members were not selected from the same department as the team chairmen. The recommended team was made up with at least one representative from engineering, tooling or industrial engineering, purchasing, production or inspection personnel, and the cost or planning department. A list of good potential "imagineers" was supplied to all the team chairmen to assist in their selection of team personnel. This list was provided from our records of people who had submitted the most—and most practical—ideas over the course of a year.

Basic rules were that each team would have at least four meetings in the course of two weeks on at least four different parts or assemblies that went into the manufacturing of the washer-dryer. A conference room was made available

with stripped-down (without cabinets) models of our combination machine and many of the basic sub-assemblies that were involved in manufacturing. To further stimulate the activities along this line, stripped-down machines were put on stands in every major department in the division. Suggestion sheets were provided at each machine, and publicity through our plant publications started the program off. A competitive attitude was encouraged by each department head to see who could come up with the best and the most cost reduction ideas.

In two weeks, over 2600 cost reduction ideas were submitted for the combination washer-dryer. Of these, 772 were good, sound and practical suggestions that were thoroughly processed. As a result, we achieved a reduction of 3.2 per cent of the unit cost through "operation cost research."



Our Pay Plan Encourages Off-Season Vacations

by RICHARD S. SHUE*

MORE AND MORE employees are becoming eligible for longer and longer vacations. To provide for three-week vacations in company policies has become standard practice and now the trend is four weeks. The result in industry, in many cases, is one of short-handed departments in the peak vacation weeks of July and August. As we are aware, insufficient manpower breeds labor problems and production difficulties.

The tool to combat the vacation dilemma logically would be that fringe benefit, perhaps most-cherished of all —vacation pay. In our company we found that this tool can be used to perform two tasks simultaneously:

1. To cater to management's need for an ample labor force at all times.
2. To cater to the employee's need for money immediately prior to his vacation.

This felicitous two-edged tool solves our labor shortage problems, caused by employees being on vacation, while promoting goodwill among the hourly-paid employees. It all adds up to better operating efficiency.

Before describing how we use this tool, our former vacation policy should be related. In the past, the entire vacation payroll was distributed on the last pay day in June, together with the regular weekly pay checks. Employees were permitted to choose their vacation weeks, from January through December, with the exception of the mill shutdown week in July (for repairs) when most of the employees were required to take a week of their vacation time. Even so, 70 per cent of the total vacation weeks allowed still remained to be taken.

What happened to a typical employee with two or three weeks' vacation pay in his pocket on the last pay day in June? He took all of his vacation time in the ensuing weeks of July or August before the money was diverted into other urgent channels. Or he took a week's vacation during the shutdown week, spent the remainder of the money in some other way and, hard pressed for funds, took his remaining vacation time later in the year. Relatively few vacations were taken in the first five months of the year. The men simply did not have the wherewithal.

Throughout July and August many departments were seriously undermanned as, each year, the total number of vacation weeks to be taken grew

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larger. This necessitated a constantly changing placement of the available manpower, assigning employees to other departments and unfamiliar jobs. When confronted with an increase of 12 per cent in the total vacation weeks, the old vacation policy clearly had become inadequate. The loss of a week's production ruled out any consideration of stopping operations for an additional compulsory vacation week. If we were to cancel the employees' prerogative to choose their time off from work, a valuable morale factor would also be lost. It was, therefore, important to encourage the men to take spring, fall and winter vacations, in order to distribute the allowable vacation weeks somewhat more evenly throughout the whole year.

There was one way in which we felt this could be done effectively: by handing every employee a vacation check on the regular weekly pay day immediately preceding the beginning of every one of his separate vacation periods. Therefore, an employee entitled to three weeks' vacation and who took these weeks separately would receive three checks, whereas he would receive one check for his full vacation pay if he took his three weeks consecutively. This method of using the vacation pay tool became the focal point of our new policy. To have vacation checks ready on a weekly basis means more work for the payroll department, but, as the additional procedures are easily integrated into the preparation of the regular weekly payroll, they are not burdensome. There are three steps between the employees submitting their vacation request forms to their foremen and receiving their vacation checks at the pay window.

1. The department foremen, informed of the week or weeks their men desire to be off from work, turn the vacation request forms into the personnel director.
2. The personnel director, with regard for the recommendations of the superintendent and the foreman concerned, approves the vacation requests whenever feasible, marks his own vacation record accordingly and, each week on the day before the calculation of the regular weekly payroll begins, gives the pack of approved vacation request forms to the payroll department.
3. In accordance with these forms, the payroll department determines the amount of each vacation pay and the appropriate withholding taxes and records these figures on the respective employees' payroll records, from which the machine operator types the vacation checks along with the regular weekly pay checks.

For payroll analysis and other purposes, a separate record is kept showing

WEEKLY DISBURSEMENT OF VACATION PAY

Date paid	No. of checks	Vacation weeks paid	Total vacation pay	Total Vacation pay to date
5/15/57	7	7	$ 628.40	$6778.60
5/22/57	11	12	1140.80	6919.40
5/29/57	9	9	812.00	7731.40
6/4/57	13	16	1543.60	9275.00

EXHIBIT 1

for each week the total amount of vacation pay included in the weekly payroll voucher, the number of vacation checks written, the number of vacation weeks paid and the cumulative amount of vacation pay disbursed during the year (Exhibit 1). Another record is kept which shows, by employees, the total vacation pay due, the number of weeks allowed and the date and amount of the check or checks written (Exhibit 2). It is from this running account of employees' vacation pay information that the amount of each check is determined on receiving the vacation request forms from the personnel director.

What basis is to be used for the calculation of vacation pay when adopting a policy which features such a multiple-week distribution of vacation checks? In arriving at a decision, each company's particular circumstances and objectives are the primary considerations, as any method for calculating vacation pay now commonly in use can be adapted to a weekly check distribution procedure. Three methods readily adaptable to this type of procedure are mentioned here:

1. *Hourly rate*—Multiply the base hourly rate, as of a fixed date, for each employee by forty hours for each vacation week.
2. *Percent of annual earnings*—Multiply the earnings of each employee for the previous year by 2 per cent for each vacation week.
3. *Fractional part of base period earnings*—Multiply the earnings for each employee within an established base period of three months, for example, by 1/13 for each vacation week. This is the method our company is using.

RECORD OF VACATION PAY DISBURSED TO EMPLOYEES

Clock No.	Name	Wks. allowed	Vacation pay	Checks Received					
				Date	Amt.	Date	Amt.	Date	Amt.
1	A. F. Smith	2	$204.80	3/27	102.40	5/22	102.40		
2	O. N. Myers	1	90.00						
3	P. K. Williams	2	182.40	4/15	91.20				
4	C. H. Miller	3	222.60	2/6	74.20	4/17	74.20	6/4	74.20
5	B. F. Warren	3	276.30	1/16	184.20	5/29	92.10		

EXHIBIT 2

The only communication to employees of the company's attitude of encouraging them to take their vacation at times other than peak summer weeks is contained in the bulletin board notice posted in January which describes the vacation plan in detail. It begins with this sentence:

> "Because of the large number of vacation weeks and our desire to satisfy everyone's choice of time, we are presenting our plan now (this year the notice was posted on January 11) so that all employees may begin thinking about and arranging for their vacations."

The notice goes on to express the advantages of winter, spring and fall vacations by stating that:

> ". . . accommodations are readily available, rates are more favorable, vacations spots are not so crowded, and the weather is generally more comfortable than during the summer."

However, the effective encouragement comes from the policy of accommodating the employees with their vacation checks at the time of their vacations.

As to the results of our new vacation pay policy, here are the facts for the first year as compared with last year under the previous policy:

1. The number of vacation weeks taken in January, February and March were doubled.
2. The number of vacation weeks taken in April, May and June were trebled.
3. The number of vacation weeks taken in July and August (excluding the shutdown week) decreased by 4 per cent of the total weeks allowed.
4. The number of vacation weeks taken in the last four months of the year varied only slightly. (Hunting season, it seems has the same adherents every year, but we believe that more employees will be attracted to autumn vacations under our new vacation pay policy in succeeding years.)

In this first year under the revised procedure, even the 12 per cent increase over the total number of vacation weeks did not cause managerial headaches. In the next several years, we expect increasingly more employees to take advantage of winter, spring and fall vacations until an optimum distribution, as limited by environmental factors and human nature, will be attained. In terms of appreciative employees and a well-modulated distribution of vacations, catering to both management and rank-and-file in the matter of vacation pay is, in itself, a profitable enterprise.

Beyond These Covers

Books

Budgeting—Principles and Practice

Herman C. Heiser, Ronald Press, 15 East 26th St., New York 10, N. Y., 1959, 415 pp., $10.

Treating budgeting as an extensive technique, i.e., one adaptable to virtually all the activities of a company, the present author has written "a practical treatise on budgeting." The three parts of the book describe (1) the place of the budget in planning and coordination (2) budget variance and analysis and reporting and (3) application of budgeting to particular internal operations, including distribution costs, research and development and capital expenditures.

Fundamental Accounting Principles

William W. Pyle and John Arch White, Richard D. Irwin, Inc., Homewood, Illinois. Revised Edition, 1959, 753 pp., $8.40.

Originally issued in 1955, this first-year college accounting text adds four new chapters in its present edition. These are "Management's Use of Accounting Data," "Budgets and Budgeting," "Statement of Sources and Applications of Funds" and "Fundamental Accounting Conventions, Concepts and Standards." The changes made elsewhere in the book are intended to strengthen material related to uses of accounting.

Guides to Successful Accounting Practice

Bernard S. Isaacson, Editor, American Institute of Certified Public Accountants, 270 Madison Avenue, New York 16, New York, 1959, 162 pp., $3.50.

"A selection of material from the *Journal of Accountancy's* Practitioner's Forum," (by the editor of the department), the counsel given here represents the offerings of 25 contributors on a wide range of aspects of public practice. These include "office procedures," "fees and billing practices," "management services," "reports to clients," "partnership and staff problems" and a number of other topics to which chapters are devoted.

C.P.A. Problems: A Complete Review Course

Arnold Johnson & Erroul S. Germain, Allyn & Bacon, 150 Tremont St., Boston 11, Mass. 1959, 30 pp., $6.95.

To be accompanied by a solutions manual soon to become available, this text contains 144 problems under 17 classifications, e.g., budgets, cost accounting, mergers and reorganization, statement analysis. These problems are directed toward helping students in preparing for the accounting practice section of the standard C.P.A. examination.

C.P.A. Problems and Approaches to Solutions Vols. I and II

Charles T. Horngren and J. Arthur Lee, Prentice Hall, 70 Fifth Avenue, New York 11, New York, 1959, Vol. I, 392 pp., $7.95, Vol. II Loose-leaf, 319 pp., $6.00.

Of these volumes, the first in its two divisions states problems from prior year examinations in accounting practice and turns to general approaches to problem areas and specific approaches to the problem given. Volume II offers solutions. In addition, the first volume closes with questions from C.P.A. examinations in theory of accounts, auditing, and commercial law, answers to which correspondingly appear at the close of Volume II.

Preparing The Office Manual

M. Graham Kellogg, American Management Association, 1515 Broadway, New York 36, N. Y. Paper Bound, 1959, 72 pp., $2.25.

This is A.M.A. "Research Study, No. 36." Written from questionnaire reports of 134 companies out of "500 firms selected at

random from a standard business directory" (and varying widely in size), this well-illustrated summary covers many facets of office manual preparation and use. These include types of manuals, their planning, writing style, reproduction, format, distribution, and revision.

Basic Business Law

David S. Craig and Rate A. Howell, Ronald Press Co., 15 East 26th St., New York 10, N. Y., 1959, 912 pp., $7.50.

This new text deals, in eleven parts, with law of contracts, agency, sales, negotiable instruments, partnerships, corporations, bankruptcy, real property, personal property and bailments, wills and the administration of estates, and insurance and suretyship. Included as appendices are the "Uniform Acts" governing sales, negotiable instruments, and partnerships.

Banking Growth in Puerto Rico

Biagio Di Venuti, Department of the Treasury, Commonwealth of Puerto Rico, San Juan, Puerto Rico.

Not an accounting book, this volume does throw light on the economy of the United State's self-governing commonwealth in the Carribean and on banking institutions there.

Articles

Using IDP for Inventory Control

Frank H. Muns, The Controller, February, 1959.

Reflecting experience of a large company in the electrical equipment field, this article describes an electronic application which "make(s) an inventory of 5,500 warehoused items readily available to 20 central regional sales offices." Leased wires and random access equipment are employed.

Control of Warehouse Costs

Thomas J. Diggory, Canadian Chartered Accountant, February, 1959.

Cost centers and allocation bases for a warehouse operation are set forth in this article with related costing forms. The principles of warehouse cost control are stated to be "to ensure that each product bears an equitable proportion of warehouse cost."

The Right Side of Accumulated Depreciation

Sidney I. Simon, Accounting Review, January, 1959.

Fairly extensively (in eight pages), the present author reexplores the question of the location in the balance sheet of accumulated depreciation, commonly "reserve" for depreciation. He sees a number of reasons—one of them the role of the item as a reserve for obsolescence also—why the depreciation reserve might be more serviceable on the right than in its present position on the left of the balance sheet as offset to fixed asset accounts.

Improvements in External Reporting by Use of Direct Costing

Robert E. Seiler, Accounting Review, January, 1959.

Known principally as a management accounting technique, direct costing has been looked on, even by some of its adherents, as of less value, if serviceable at all, for financial accounting. The author of this article reviews the topic and relates direct costing to income determination, "stockholder appraisal of management," and to various public interests in financial accounts.

Accountability in a Nationalised Industry

Henry W. McQ. Hembry, The Federal Accountant, December, 1958.

The accounting side of Britain's nationalized coal industry is here described in some detail under heads (among others) of "financial control," "accounting arrangements" and "audit and efficiency services." Under the second of these, interunit transactions, selection of interim accounting periods and banking arrangements are treated.

The Distribution Cost Problem

Hadley P. Schaefer, Accounting Review, October 1958.

Analysis of distribution costs by "natural expense," "function," and "manner of application of distribution effort" are explained in this paper. As to the last-named, the author states, "Management maximizes benefits from distribution accounting by selecting significant objectives for periodic analysis and disclosure."

Effective Understanding and Utilization of Standard Costs

Donald C. Brabston, Journal of Accountancy, May, 1959.

"It seems probable that more cost systems, particularly standard, have been allowed to operate at only a fraction of maximum utilization because of lack of understanding by management than from any other known cause." A program of achieving such an understanding is presented in this article, following introductory material from which the foregoing quotation is taken.

A Simplified Standard Cost System for a Continuous Profit Operation

George W. Frank, The Controller, April, 1959.

The standard cost system described here was installed for control uses relating to a specific large-volume product in a chemical company. It is suggested in a note to the paper that pharmaceutical, food, paint and certain other types of manufacturers might benefit from this particular adaptation of standard costs.

Punched Tape Accounting for Smaller Business

Donald A. Schwartz, Journal of Accountancy, May, 1959.

Here advocated as practical, at least if a data processing service bureau is also available, is a "tape adding machine . . . with a tape punching mechanism attached so that a punched paper tape as well as a printed adding machine tape is created with each stroke of the motor bar keys." The data is for further processing "by tabulating or computing equipment."

The Analysis of Your Spending Decisions

George A. Taylor, The Controller, April, 1959.

Intended to "provide the businessman with the abc's of his spending decisions and to give him an understanding of the principles on which the mathematical analysis is based," this article uses four examples of problems requiring solution, sets up solutions and provides a set criterion for spending decisions.

ADDRESSES OF PERIODICALS

The Controller

2 Park Avenue
New York 16, N. Y.
Single copy: 65¢

Journal of Accountancy

270 Madison Avenue
New York 16, N. Y.
Single copy: 85¢

The Federal Accountant

P.O. Box 53, Washington 4, D. C.
Single copy: $1.25

Canadian Chartered Accountant

69 Bloor St. E.
Toronto 5, Ontario, Canada
Single copy: 50¢

Accounting Review

c/o R. Carson Cox,
College of Commerce,
Ohio State University,
Columbus 10, Ohio
Single copy: $1.50

What Do We Mean By Return on Investment

by J. M. WHALEN

DO WE ALL MEAN the same thing when we refer to "return on investment"? It appears that we do not and that it is quite probable that the terminology, "return on investment", has been confusing, particularly to the uninitiated, in that it has been used indiscriminately to describe two different types of financial measurement which are made for different purposes. As in other areas of accounting, accountants seem to find it difficult to achieve uniform terminology which will convey substantially the same meaning to the majority of those who use accounting information and read accounting literature.

Generally speaking, most of the recent writing and discussion has concerned itself with the measurement of the rate of return on the total assets employed in the business for the purpose of measuring the effectiveness of operating management. This measurement is often referred to by those who discuss and write about it as "return on investment". While no one can say that such terminology, broadly speaking, is incorrect when used in this manner, it is confusing, since it can be, and is, used to describe another kind of financial measurement.

The two different measurements which are more or less indiscriminately referred to as "return on investment" may generally be defined as "return or yield on equity capital" and "return on total capital employed". I. Wayne Keller makes a rather clear distinction between the two in an article entitled "The Return on Capital Concept" appearing in the N.A.A. *Bulletin* of March, 1958. It will serve our purpose here to quote as follows from Mr. Keller's article.

> *"Yield on Equity Differentiated from Return on Capital*
>
> The return on capital ratio is an internal measure of operating management. It is not necessarily a guide for equity investors. It is for this reason that the term 'return on capital' is preferable to 'return on investment' for internal use. 'Investment' carries the connotation of equity capital rather than total capital.
>
> The return or yield on investment has some limited value as an internal measure but it is primarily an investor's guide."
>
> * * *
>
> "The yield on investment, including the leverage factor, is a measure of financial management, not of operating management."

* Collins Radio Co., Cedar Rapids, Iowa.

"Composition of Capital Employed

Having considered the *yield on investment,* let us return to internal profit measurement and appraisal and ***return on capital employed.*** . . . For internal measurement the sources of the assets is unimportant. The significant question is how profitably they are being employed. A dollar provided by vendor credit should be used just as profitably as a dollar secured from the sale of stock."

It can be concluded from the foregoing that Mr. Keller would use "return on investment" to describe the measurement of return or yield on equity capital and would employ the terminology, "return on capital employed", to measure the return on total assets used by operating management in the conduct of the business. That this distinction in terms is not generally made can be rather clearly demonstrated.

From an excellent article by W. G. Livingston and E. B. Mills entitled "Return on Investment — A Guide to Decision Making" and appearing in the October 1958 *Bulletin,* the following is quoted.

> "Let us define our terms. We accountants have a bad habit of using the same terms to mean different things — so we will define what we mean in our use of some of the more common terms. Capital is the source of funds that are acquired from stockholders, short and long term borrowings, and accumulated earnings. Investment is the use to which capital derived from such sources is put, such as plant and equipment, inventories and receivables."

Here the term investment is used to describe the internal employment of the company's assets regardless of their source and, in this article, the terminology "return on investment" is used to describe what some would call "return on capital employed".

That there are two types of measurement to be made in the field loosely referred to as "return on investment", that they are different and are used for different purposes would seem to be clear. It would also seem reasonable to expect that terminology will develop to distinguish one from the other. It seems to me that Mr. Keller's article referred to earlier suggests a clear and useful distinction in terminology which could be beneficially adopted. That is—

1. *Return on investment* — to denote the measure of return or yield including leverage on equity capital.
2. *Return on capital employed* — to denote the measure of return on total assets employed in the operation of the business regardless of source.

I cannot help but think that the emergence of definitive language in whatever form which will make the foregoing distinction in meaning will serve to avoid confusion in the minds of a good many who read accounting literature dealing with this general subject.

Understandable Reporting of Variance From Plan

by R. E. PALMER*

THE EVOLUTION of various accounting concepts down through the years has resulted in expressing results of business operations in many different forms. The measure of results, as set forth in reports, has changed from time to time, by showing comparisons of actual results to past performance, standards, forecasts, budgets and, more recently, to fit in with complete profit planning. These changes have left segments of various levels of management stranded on "islands." Each has a full understanding of one method, a vague understanding of another and a confused distrust of methods not fully understood and accepted. The entire problem is further complicated by the inflexible attitude of most profit planners and budget managers. Such plans, by their very nature, are prepared from three to fifteen months in advance of the period and, usually, do not make provision for adjustment for changes of major basic factors.

The following schedule is suggested as a procedure by which to accomplish the desirable objectives of all methods of measurement and to eliminate the frustration and wasted effort of attempting to reconcile and explain the difference shown among the various methods:

1. Results should be recorded, forecast and published as follows—

	Standard cost (A)	*Planned and/or authorized variance* (B)	*Adjusted standard and profit plan* (C)	*Actual cost* (D)	*Variance D-C* (E)
Materials (output)	X	X	X	X	X
Materials (input)	X	X	X	X	X
Expenses (by classification)	X	X	X	X	X

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2. Column A provides the operator with either the long-term goal or the optimum result, depending on the desires of those establishing the standard.
3. Column B provides the authorization to plan variances and to make proper dollar allowances for changes in mode of operations forced upon the operator for reasons beyond his control.
4. Column C then becomes the adjusted standard or goal for the current period and also becomes the yardstick for performance in all areas. The amounts in column C also become the basis for the profit plan which is then based upon current and realistic factors.
5. Column D reflects the actual cost recorded against the operations. The difference between Columns D and C finally reflects a true measure of the current results and provides variance information for profit plan reporting. This, of course, assumes that the profit plan itself is constructed in the same format as the plant reports and that the figures are used without further change.

When the above concept has gained understanding and acceptance and when all reporting is developed from this base schedule consistently, the results for all uses will be consistent, adequate, properly controlled and explained.